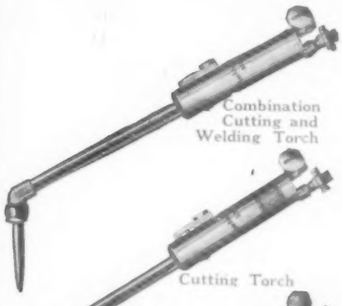
The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

FEBRUARY, 1928 VOL. 13, No. 2

$3.00 per year in U. S. 608 S. Dearborn St., Chicago, Ill. $4.00 per year abroad



Combination Cutting and Welding Torch

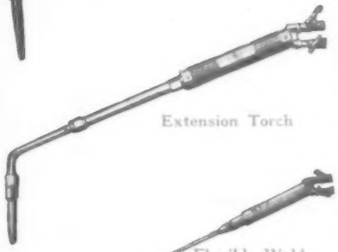
Cutting Torch

Regulators for all Gases

EVERYTHING IN GAS WELDING AND CUTTING

Low Pressure and Illuminating Gas Cutting Torch

Welding Torch



Extension Torch

Flexible Welding Torch

MILBURN is serving the industry with the most complete line of welding and cutting apparatus.

Automobile manufacturers, railroads, gas producing companies and many other industrials have put all their welding and cutting problems to the Milburn Engineers. Special torches and equipment for their particular operations to increase production and cut costs are produced in this plant.

Milburn Apparatus is constructed of special materials. Bronze forgings, stainless steel tubing of extra thicknesses, pure copper and bronze parts, valves easily accessible—these are just a few Milburn features. Backed by over 20 years of pioneering in the industry.

Catalog 35 upon request

Acetylene Generators

Outfits

Outfits

THE ALEXANDER MILBURN CO.

BALTIMORE, MD.

Established 1907

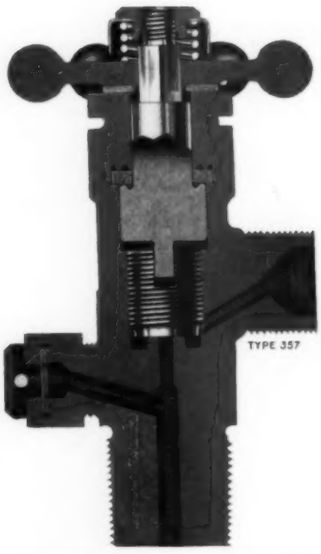
The World's Best Welding and Cutting Equipment

Desirable Territories open for Representation

Published monthly by the Welding Engineer Publishing Co. Entered as second class matter Jan. 20, 1916, at the Post Office at Chicago, Ill. Under the Act of March 3, 1897.

KEROTEST

PITTSBURGH VALVES



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A FEW CENTS

additional, invested in

Pittsburgh Quality Valves

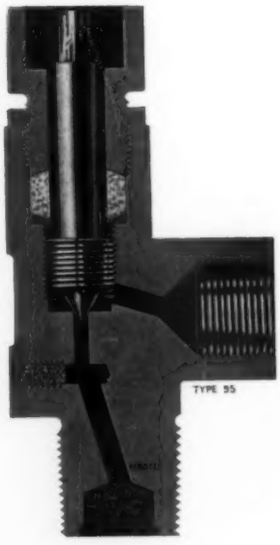
will pay you Big Returns in

Satisfied Customers

Freedom of Complaints

Minimum Maintenance Cost

Let us submit samples, and show you what we have to offer.



TYPE 95
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Kerotest Manufacturing Co.
2525 Liberty Avenue
Pittsburgh, Penna.

Service to Airco Customers from Airco Plants and District Sales Offices

Airco District Offices
Baltimore, Md. Milwaukee, Wis.
Birmingham, Ala. Minneapolis, Minn.
Boston, Mass. Jersey City, N. J.
Buffalo, N. Y. Oklahoma City, Okla.
Chicago, Ill. Philadelphia, Pa.
Cleveland, O. Pittsburgh, Pa.
Dayton, O. Richmond, Va.
Detroit, Mich. St. Louis, Mo.
Emeryville, Cal. Seattle, Wash.
Los Angeles, Cal. Wheeling, W. Va.
Charlotte, N.C.
Air Reduction Sales Company
36 Oxygen Plants 2 Carbide Plants
19 Acetylene Plants 21 District Offices
2 Calorene Plants 110 Distributing Points
THIS TAG IS ON EVERY AIRCO OXYGEN CYLINDER
Buy Your Oxygen On Specification for Purity
AIRCO OXYGEN IS 99.5% PURE IN THE CYLINDER
The Purest Oxygen is Always the Most Economical

Airco Plants and Sales Offices are located at various industrial centers and advantageous shipping points to assure good service with Airco products—

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ACETYLENE	CUTTING TORCHES
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NITROGEN	ACETYLENE REGULATORS
ARGON	OXYGEN MANIFOLDS
NEON	ACETYLENE GENERATORS
HELIUM	CUTTING MACHINES
CARBIDE	WELDING SUPPLIES

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65 Plants **110 Distributing Points** **21 District Offices**

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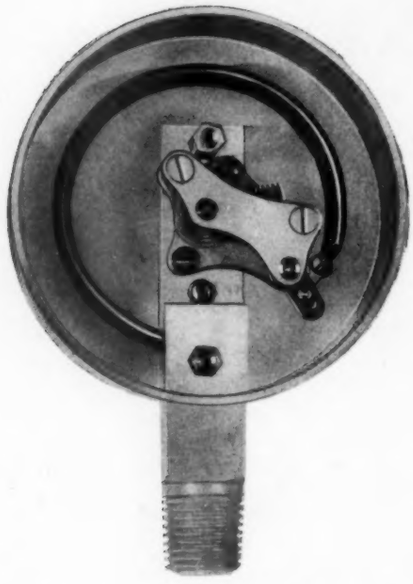
Oklahoma City
Philadelphia
Pittsburgh
Richmond
Seattle
St. Louis
Wheeling

Home Office—342 Madison Ave., New York City, N. Y.

DANTE Alighieri, as visualized in the striking bronze statue by Ettore Ximenes, located at Broadway and 63rd St., New York City.



Enduring Bronze

Just as the famous sculptors of the world select enduring bronze for their statues, because no other material resists so well the destructive effects of the weather, so has enduring bronze been selected as the material for Natweld Gauge bourdon springs.

But Natweld Springs must be better than statuary bronze to pass our rigid performance tests. So they are manufactured by treating this enduring material by certain processes that give added life, added resiliency, and added dependability to its natural characteristics.

Yet Natweld Gauges, by reason of quantity production and mass sales, cost no more than an inferior product.

NATIONAL GAUGE & EQUIPMENT CO.
La Crosse, Wisconsin
A Division of The Moto-Meter Company, Inc.

The Moto-Meter Co. of Can. Ltd., Hamilton, Ontario
Chicago Office: 820 Tower Ct.
Represented in Illinois, Indiana, Wisconsin, Minnesota and Missouri
By Joseph Halla, Chicago, Illinois

NATWELD GAUGES

The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 13 | February, 1928 | Number 2

CONTENTS

Navy Welds Aerial Practice Bombs 25
By O. P. Murry and C. N. Grubbs

Welding Power Plant Piping 27
By A. W. Moulder

Welding Trusses for Industrial Buildings 33
By Andrew Vogel

G. P. A. Midwinter Meeting 37

The Redshortness of Weld Metal 39
By A. H. Goodger

Editorial 23

Welding Taught at San Francisco School 31
C. G. M. A. Convention 32
Conference at North Texas Agricultural College 36
Gear Remodeled by Oxygen Lance 43
Annealing of Welded Pipe 44
Building up a Worn Shaft 45
Announce California Welding Exposition 45
New York Master Plumbers Study Welding 47
Plans Out for Philadelphia Exposition 47
Metal Radioscopy 48
News of the Welding Trade 51

Who Reads Advertising?

TWENTY years ago, or more recently than that, some might be heard to ask derisively, "Who reads advertising?" Today we can put that question directly and expect an answer. Who does read advertising, particularly industrial advertising?

The man whose responsibility it is to buy at the best price consistent with quality, or to buy the best quality obtainable for a price—it is his business to read and study the advertisements.

The man whose job it is to keep the plant running at top-notch efficiency—he has found that it pays to read the plant equipment advertising.

The man in charge of production—no one knows better than he how important it is to "read the ads" in order to keep abreast of new developments in materials or production tools.

Today, the engineer, foreman, or operator who fails to read the advertising in his own industry is pretty sure to become a "back number" before long. An industrial advertisement serves a useful purpose. Who *doesn't* read advertising?

Published on the 15th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
608 S. Dearborn St., Chicago, Ill.
Telephone Wabash 7134

G. H. Mackenzie ..... President and Treasurer
M. J. Hungerford ..... Vice-President
H. S. Card ..... Secretary

H. S. Card ..... Editor
H. P. Ritsch ..... Associate Editor

Eastern Office—222 American Circle Bldg., New York
T. E. DePew, Eastern Manager
Telephone, Columbus 6941

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The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 12th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails. All copy should be in by the 12th of the month at the latest.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

Authorized Representatives

CLEVELAND—R. K. Randall, 2094 E. 19th St.
DENVER—A. G. Odell, Public Opportunity School.
GREAT BRITAIN—Capt. D. Richardson, 26 Winterbrook Road, Herne Hill, London.
AUSTRALIA AND NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand.
SOUTH AFRICA—J. W. Arnison, 35a Victoria Ave., Benoni, Transvaal, South Africa.

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
International Oxygen Co.
Prest-O-Lite Co.

ACETYLENE CYLINDERS
Keith Dunham Company
Pressed Steel Tank Co.

AIR LIQUEFACTION OXYGEN PRODUCING PLANTS
Keith Dunham Company
Heylandt Sales Co.

ALUMINO-THERMIC WELDING
Metal & Thermit Corporation

ALUMINUM SOLDER
Crown Aluminum Solder Co.
Weldene Corporation

ANNEALING FURNACES
General Electric Co.
Westinghouse Elec. & Mfg. Co

APRONS (Asbestos)
Ideal Face Shield Co.

ASBESTOS INSULATED WIRE AND CABLE
Central Steel & Wire Co.

BLOW PIPES
See "Torches."

BOOKS
The Welding Engineer Pub. Co.
Electric Arc Cutting & Welding Co

BRAZING OUTFITS
Air Reduction Sales Co
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
Williams & Co.

BRONZE FILLER RODS
American Brass Co.
Central Steel & Wire Co.
Krembs & Co.
Mueller Brass Co.
Steel Sales Corp.

BUFFERS
R. G. Haskins Co.
N. A. Strand & Co.

BUTT WELDERS
See "Electric Resistance Welders"

CABLE (Arc Welding)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Lincoln Electric Co.
Quasi-Arc Weldtrode Co.
Una Welding and Bonding Co.
U. S. L. Battery Corp.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CARBIDE
Air Reduction Sales Co.
National Carbide Co.
Shawinigan Products Corp.
Union Carbide Sales Co.

CARBON (Blocks, Paste, Electrodes, etc.)
Air Reduction Sales Co.
Electric Arc Cutting & Welding Co.
Harris Calorific Co.
National Carbon Co.
Oxweld Acetylene Co.

CARBON BURNING EQUIPMENT
Air Reduction Sales Co
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

CAST IRON SOLDER
Crown Aluminum Solder Co.
Weldene Corporation

CONSULTING ENGINEER
E. F. Hollinger
R. E. Kinkead
R. C. Pierce

CONTRACT WELDERS
S. O. S. Welding Corp.

CUTTING ELECTRODES (Electric Arc)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Lincoln Electric Co.
National Carbon Co.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CYLINDERS (Acetylene)
Keith Dunham Company
Pressed Steel Tank Co.

CYLINDERS (Oxygen, Hydrogen)
Wm. Wharton, Jr. Co.

DRILLS, PORTABLE ELECTRIC
Stoody Company
N. A. Strand & Co.

ELECTRIC ARC WELDING OUTFITS
Allan Mfg. & Welding Co.
Burke Electric Co.
Chicago Steel & Wire Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
General Electric Co.
Goodman Electric Machinery Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Lincoln Electric Co.
E. A. Lundy Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Stoody Co.
Una Welding and Bonding Co.
U. S. L. Battery Corp.
Waters Arc Welding Corp.
Welding Service Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRIC RESISTANCE WELDERS
Federal Machine & Welder Co.
General Electric Co.
Gibb Welding Machines Co.
Goodman Electric Machinery Co.
R. D. Thomas Co.

ELECTRODES (Carbon Arc Welding)
See "Cutting Electrodes"

ELECTRODES (Metallic Arc Welding)
American Steel & Wire Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Chicago Steel & Wire Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corporation
Koro Corporation
Lincoln Electric Co.
Page Steel & Wire Co.
Quasi-Arc Incorporated
Reid-Avery Co.
Roebling, John A., Sons Co.
Standard Steel & Wire Co.
Steel Sales Corp.
Stoody Company
Una Welding and Bonding Co.
Waters Arc Welding Corp.
Welding Service Co.
Wickwire Spencer Steel Corp.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE HOLDERS
Allan Mfg. & Welding Co.
Burke Electric Co.
Chicago Steel & Wire Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Koro Corporation.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Una Welding and Bonding Co.
U. S. L. Battery Corp.
Waters Arc Welding Corp.
Welding Service Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE TIPS (Resistance Welding)
Elkon Works, Inc.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
International Oxygen Co.

FACE SHIELDS (Arc Welding)
Allan Mfg. Co. & Welding Co.
Burke Electric Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Stoody Company
Strauss & Buegeleisen
Una Welding and Bonding Co.
U. S. L. Battery Corp.
Waters Arc Welding Corp.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

FILLER RODS
Air Reduction Sales Co.
American Brass Co.
American Steel & Wire Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Craftsweld Equipment Co.
Oxweld Acetylene Co.
C. H. Hollup Corp.
Imperial Brass Mfg. Co.
Krembs & Co.
Mueller Brass Co.
Koro Corporation
Page Steel & Wire Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
St. Paul Welding & Mfg. Co.
Standard Steel & Wire Co.
Steel Sales Corp.
Stoody Co.
Stulz-Sickles Co.
Torchweld Equipment Co.
Welding Service Co.
Wickwire Spencer Steel Corp.
Weldit Acetylene Co.
Williams & Co.

FIREPROOF PLASTIC MATERIAL
Air Reduction Sales Co.
Joseph Dixon Crucible Co.
National Carbon Co.

FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
Anti-Borax Compound Co.
Metal & Thermit Corp.
Central Steel & Wire Co.
Krembs & Co.
Modern Engineering Co.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.
Torchweld Equipment Co.
Weldene Corporation
Weldit Acetylene Co.

GAS SAVING DEVICES
Harris-Calorific Co.
Weldit Acetylene Co.

New *and* Striking Features *in the* *Wilson Model S Welder!*

Wilson Model S Welding Machine, one-operator electric-motor-driven Type 200 amperes, welding range 10 to 300 amperes.

WILSON WELDING MACHINE DISTRIBUTORS

Joseph T. Ryerson & Son, Inc.
16th & Rockwell Sts., Chicago, Ill.
Lock Box 484, Jersey City, N. J.
Box 996, Buffalo, N. Y.
531 Pittsburgh Life Bldg., Pittsburgh, Pa.
E. 53rd St. & Lakeside Ave., Cleveland, O.
1600 E. Euclid Ave., Detroit, Mich.
Station N, Box 36, Cincinnati, Ohio
2208 North 2nd St., St. Louis. Mo.
1008 Union Nat. Bank Bldg., Houston, Tex.

Austin-Hastings Co., Inc.
226 Binney St., Kendall Square,
Cambridge "C", Boston, Mass.

Oliver H. Van Horn Co., Inc.
522 Camp St., New Orleans, La.

Smith Booth Usher Co.
228 Central Ave., Los Angeles, Calif.
50 Fremont St., San Francisco, Calif.

Foreign

American Trading Company
(Japan and dependencies)
25 Broad Street, New York City

Amsterdamsch Kantoor voor Indische Zaken
(Dutch East Indies)
B. G. D. Ter Braake,
85 St. Marks Avenue, Brooklyn, N. Y.

Baldwin Locomotive Works
(South America, West Indies, Continental Europe, Northern Manchuria)
Philadelphia, Pa.

International Railway Supply Co.
(South America, Central America, Cuba, Mexico, China, Philippine Islands)
30 Church Street, New York City

G. D. Peters & Company, Ltd.
(Great Britain, Ireland, South Africa, India, Australia, New Zealand, Denmark, Spain, Portugal)
Caxton House, Westminster,
London, S. W. 1, England
1001 New Birks Bldg., Montreal, Canada

INTERESTING *new features* give the Wilson Model S Machine the highest degree of efficiency yet obtained in arc welding equipment. Its frame is of angle iron construction, welded throughout, and made narrow for easy handling in shops. The improved reactor is mounted over the rear axle to protect it from injury. There are no live parts on the front of the modified control panel. A new rotary switch, together with a new design of field rheostat, afford very fine adjustments of the welding current. Exceedingly close regulation is available for strength welding, while a long arc with heavy current is available for rapid depositing of metal. Close control and quick recovery make the machine ideal for overhead welding, and the standard machine welds the thinnest sheet metal that the electric arc can handle. The Wilson Model S Welding Machines are equipped to give full welding range without extra apparatus or extra cost.

One-operator	Motor	Generator	Set	Type 200 Amps.,	welding	range	10 to 300 amps.
One-operator	"	"	"	Type 300 Amps.,	"	"	15 to 400 amps.
Two-operator	"	"	"	Type 400 Amps.,	"	"	10 to 300 amps. or 300 to 600 amps.
Two-operator	"	"	"	Type 600 Amps.,	"	"	15 to 400 amps. or 400 to 800 amps.
One-operator	Gasoline Engine		Driven	Type 200 Amps.,	"	"	10 to 250 amps.
One-operator	"	"	"	Type 200 Amps.,	"	"	10 to 300 amps.
One-operator	"	"	"	Type 300 Amps.,	"	"	15 to 400 amps.
One-operator	Belt		Driven	Type 200 Amps.,	"	"	10 to 300 amps.
One-operator	"	"		Type 300 Amps.,	"	"	15 to 400 amps.

WILSON WELDER & METALS CO. INC., WILSON BUILDING, HOBOKEN, N. J.

WILSON

WELDING MACHINES AND WELDING WIRE

GLOVES (Asbestos)
Ideal Face Shield Co.

GAUGES
Moto Meter Co.
National Gauge & Equipment Co.

GENERATORS (Acetylene)
Air Reduction Sales Co.
Craftsweld Equipment Co.
M. Keith Dunham
Imperial Brass Mfg. Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.

GOGGLES
Chicago Eye Shield Co.
Ideal Face Shield Co.
Strauss & Buegeleisen
Willson Goggles, Inc.

GRAPHITE (Rods, Blocks, Paste, Etc.)
Joseph Dixon Crucible Co.

GRINDERS (Portable Electric)
R. G. Haskins Co.
Stoody Company.
N. A. Strand & Co.

HELMETS (Arc Welding)
Allan Mfg. & Welding Co.
Burke Electric Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Strauss & Buegeleisen
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

HOSE COUPLINGS
Carl A. Norgren Co.
See also under "Needle Valves"

HYDROGEN
Gas Products Association
International Oxygen Co.

HYDROGEN GENERATING PLANTS
International Oxygen Co.

LEAD WELDING UNITS
Air Reduction Sales Co.
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Modern Engineering Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
Weldit Acetylene Co.

LIGHTERS (For Gas Torches)
Air Reduction Sales Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Stevenson Distributing Corp.
Torchweld Equipment Co.

MANIFOLDS
Air Reduction Sales Co.
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

MECHANICALLY OPERATED CUTTING AND WELDING TORCHES
Air Reduction Sales Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

MOLDING MATERIAL
See "Fire Proof Plastic Material"

MONEL METAL RODS AND ELECTRODE
Central Steel & Wire Co.
Wilson Welder & Metals Co.

NEEDLE VALVES
Air Reduction Sales Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

NITROGEN
Air Reduction Sales Co.
Gas Products Association
Linde Air Products Co.
International Oxygen Co.

OXYGEN
Air Reduction Sales Co.
Gas Products Association
International Oxygen Co.
Linde Air Products Co.

OXYGEN PRODUCTION PLANTS
Keith Dunham Company
Heylandt Sales Co.

PREHEATING DEVICES AND OVENS
Imperial Brass Mfg. Co.
Metal & Thermit Corp.
St. Paul Welding & Mfg. Co.

RAIL BONDS
Una Welding and Bonding Co.

RAIL JOINT WELDERS
Una Welding and Bonding Co.

REAMERS (Portable Electric)
R. G. Haskins Co.
N. A. Strand & Co.

REGULATORS
Air Reduction Sales Co
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.
Stoody Company
Torchweld Equipment Co.
Weldit Acetylene Co.
Williams & Co.

SEAM WELDERS
See "Electric Resistance Welders"

SWEDISH IRON WELDING WIRE
Bissett Steel Co.

SPOT WELDERS
See "Electric Resistance Welders"

TANK CONNECTIONS
Air Reduction Sales Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

THERMIT WELDING
Metal & Thermit Corp.

TORCHES (Welding and Cutting)
Air Reduction Sales Co
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.
Stoody Company
Torchweld Equipment Co.
Weldit Acetylene Co.
Williams & Co.

TRUCKS (Cylinder)
Air Reduction Sales Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Torchweld Equipment Co.

VALVES
Air Reduction Sales Co.
International Oxygen Co.
Kerotest Mfg. Co.

WELDING COMPOUND (for Shape Welding)
Air Reduction Sales Co.
Harris Calorific Co.
Joseph Dixon Crucible Co.
Modern Engineering Co.
National Carbon Co.

WELDING ROD HOLDERS
C. Sorensen

WELDING RODS AND WIRE
See "Electrodes" and "Filler Rods"

ALPHABETICAL INDEX TO ADVERTISERS

A

Air Reduction Sales Co. 3
Allan Mfg. and Welding Co. 65
American Brass Co., The 51
American Steel & Wire Co. 61
American Welding Society 62
Anti-Borax Compound Co. 66
Atlas Foundry Co. 54

B

Bissett Steel Co. 53
Burke Electric Co. 64

C

Central Steel & Wire Co. 9
Chicago Eye Shield Co. 60
Chicago Steel & Wire Co. 56
Commercial Acetylene Supply Co. 57
Craftsweld Equipment Co. 65
Crown Aluminum Solder Co. 60

D

Dixon Crucible Co., Joseph 64

E

Elec. Arc Cutting & Welding Co., Back Cover
Elkon Works, Inc. ..... Inside Back Cover
Electric Welding Machine Co. 11

F

Federal Machine & Welder Co. 53
Fibre Metal Products Co. 66
Fusion Welding Corporation 56

G

Gas Products Assn. 10
General Electric Co. 19
Gibb Welding Machine Co. 63
Goodman Electric Mach. Co. ....

H

Harris Calorific ....
R. G. Haskins Co. 63
Hollup, C. H. 58

I

Ideal Face Shield Co. 64
Imperial Brass Mfg. Co. 59
International Oxygen Co. 62

K

Kerotest Mfg. Co. 2
K-G Welding Co. 55
Kinkead, R. E. 66
Koro Corporation 60
Krembs & Co. ....

L

Lincoln Electric Co. 12
Linde Air Products Co. 15

M

Metal and Thermit Corp. ....
Alexander Milburn Co. ..... Front Cover
Modern Engineering ....
Moto Meter Co. 4
Mueller Brass Co. 13

N

National Carbide Co. 58
National Carbon Co. ....
National Gauge and Equipment Co. 4
Northwestern Mfg. Co. 63
Norgren, C. A., Co. 66

O

Owen Electric Mfg. Co. 17
Oxweld Acetylene Co. 16

P

Page Steel & Wire Co. 57
Pierce, R. C. ....
Pressed Steel Tank Co. 59
Prest-O-Lite Co., Inc., The 14

Q

Quasi Arc, Incorporated 21

R

Roebling, John A., Sons Co. 24

S

Sorensen, C. 66
Shawinigan Products Corp. 65
Standard Steel & Wire Co. 52
Stevenson Distributing Corp. 62
Steel Sales Corp. 55
Strauss & Buegeleisen 66
Strand, N. A., & Co. 66
Stoody Co. 64
S. O. S. Welding Corp. ....
St. Paul Welding & Mfg. Co. 66

T

Torchweld Equipment Co. 56

U

U. S. L. Battery Corporation 61

W

Weldene Corporation ....
Weldit Acetylene Co. 62
Westinghouse Electric & Mfg. Co. 22
Wickwire Spencer Steel Corp. 54
William Wharton, Jr., & Co., Inc. ....
Williams & Co., Inc. 63
Willson Goggles, Inc. 65
Wilson Welder & Metals Co. 7

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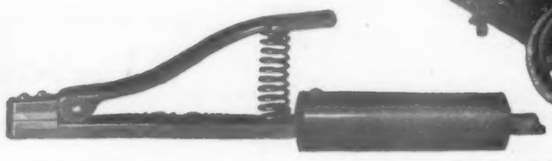

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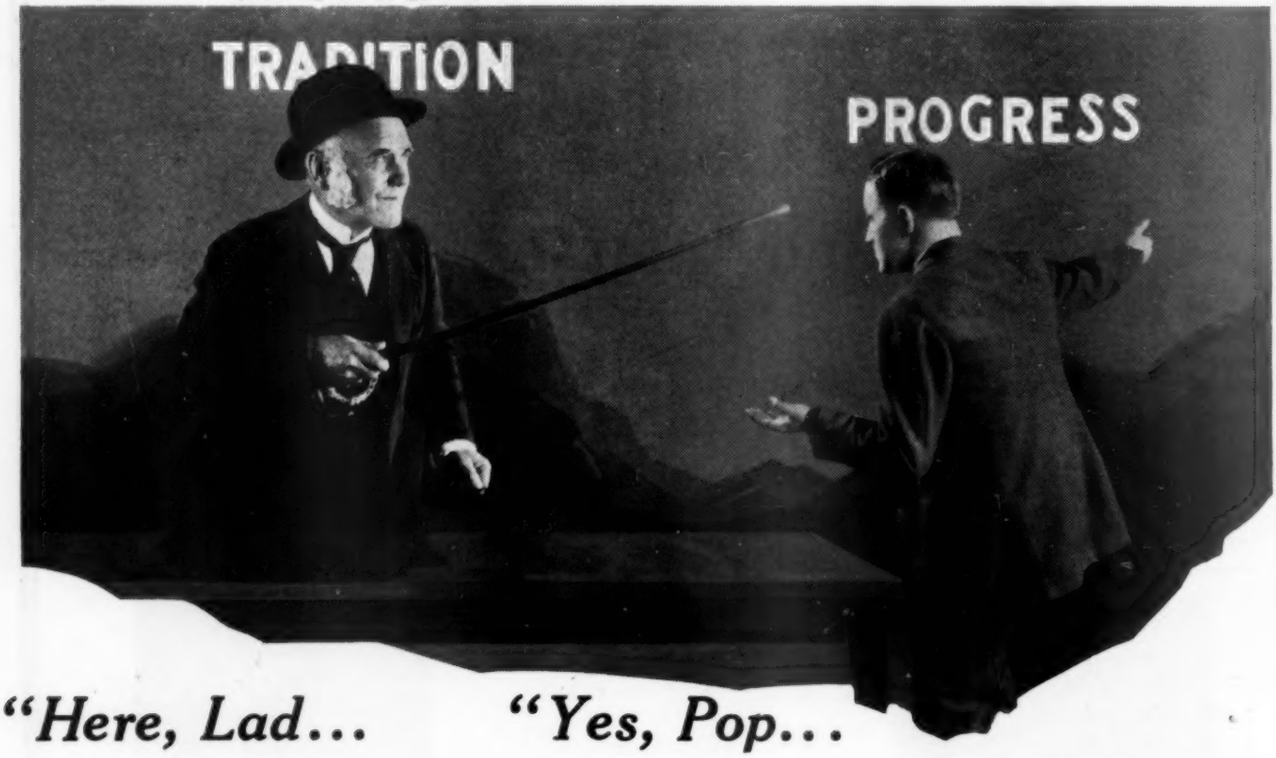

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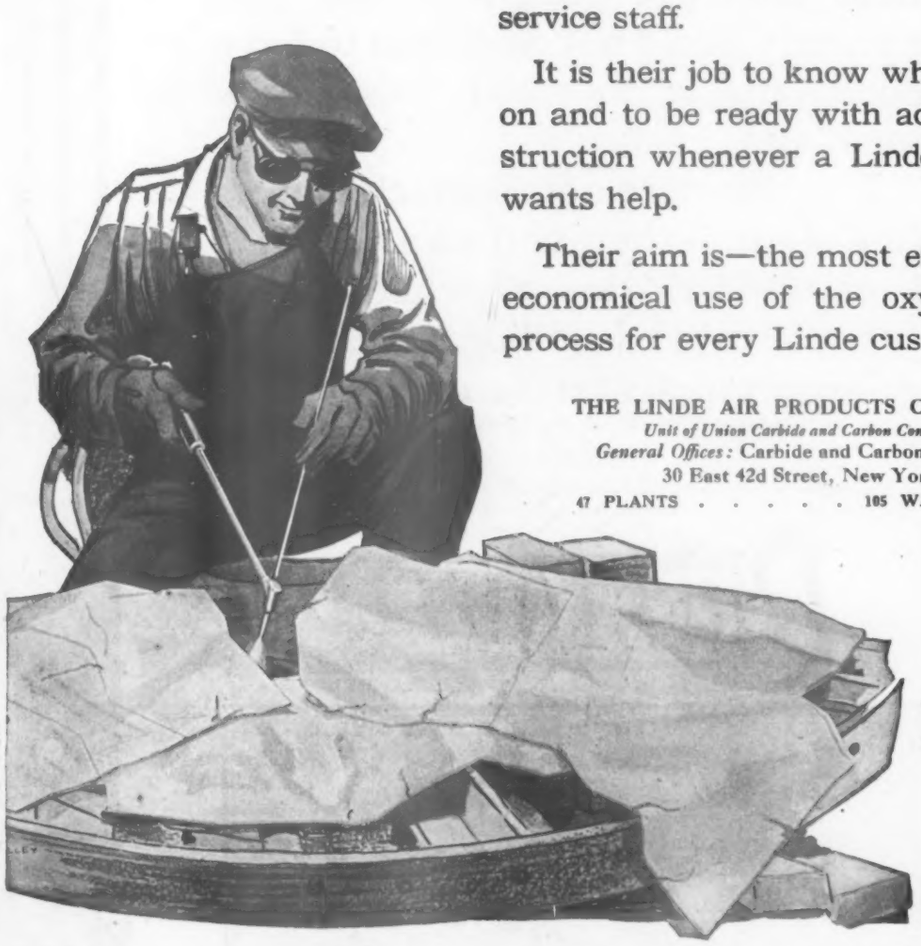

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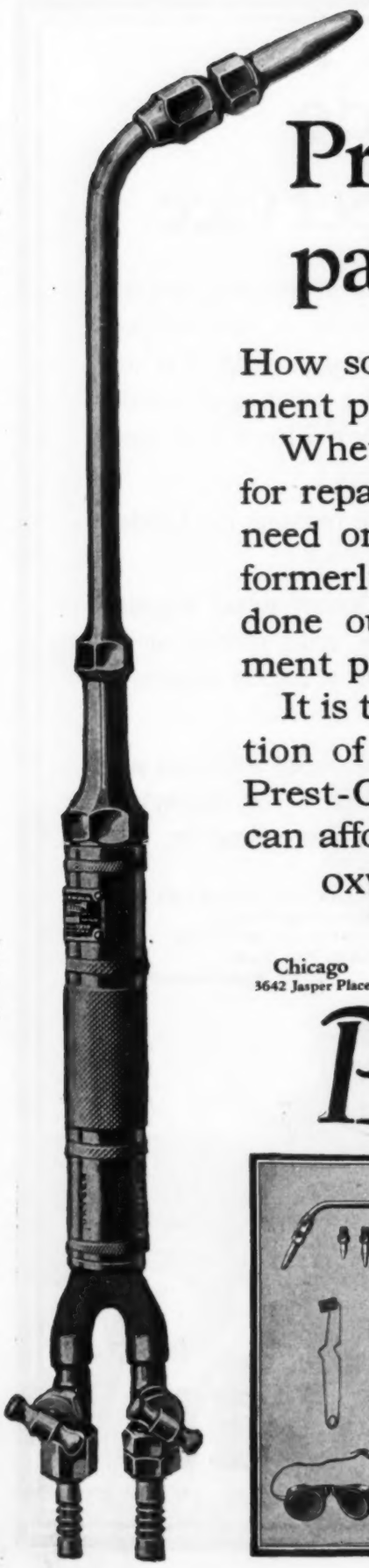

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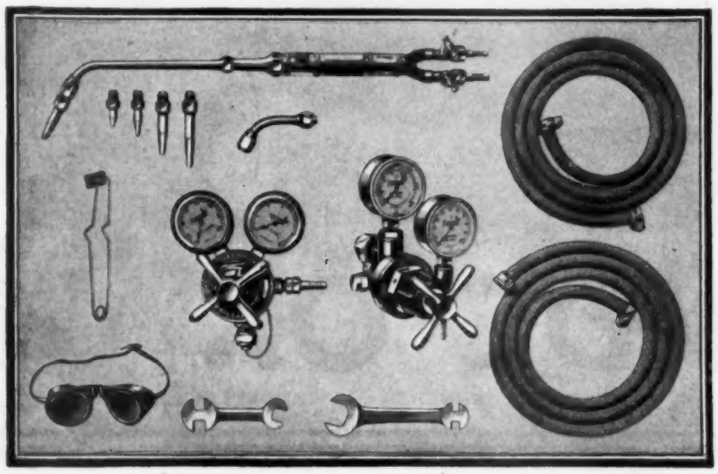

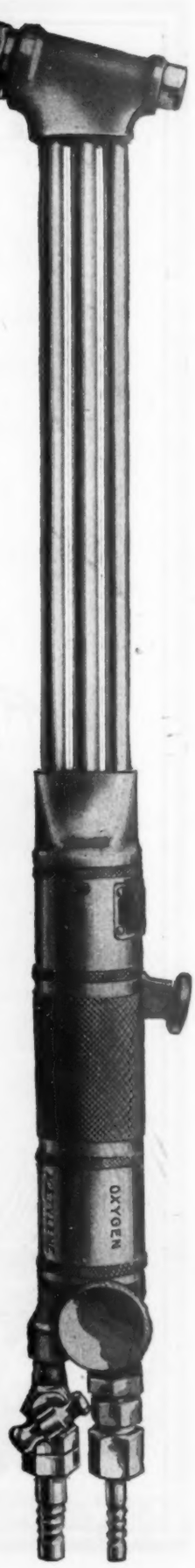

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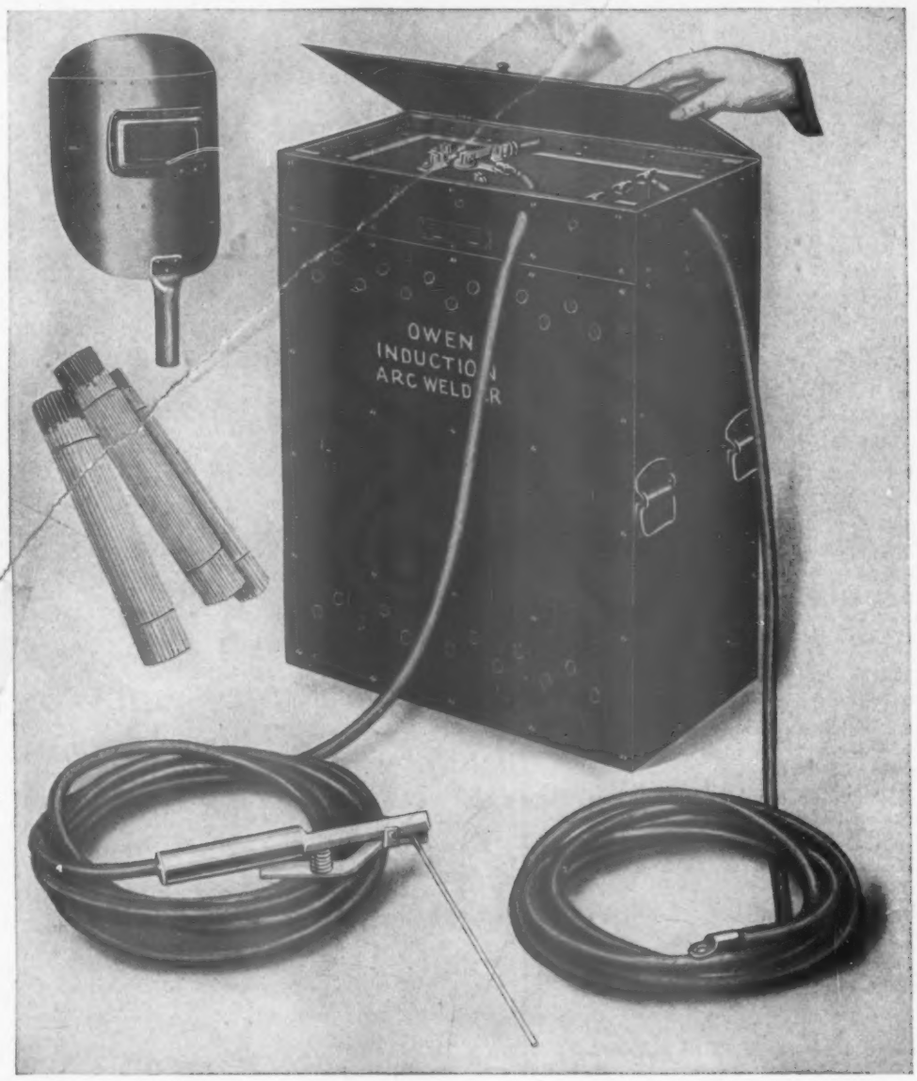

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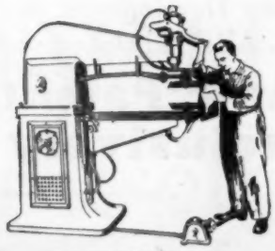

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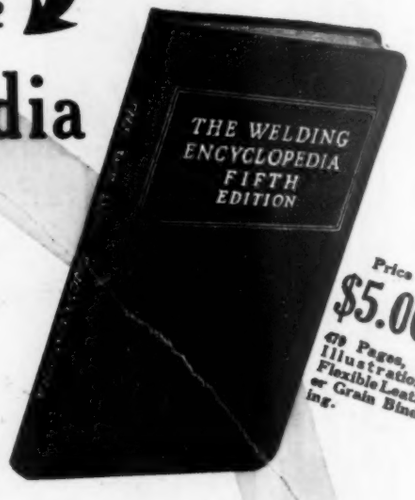

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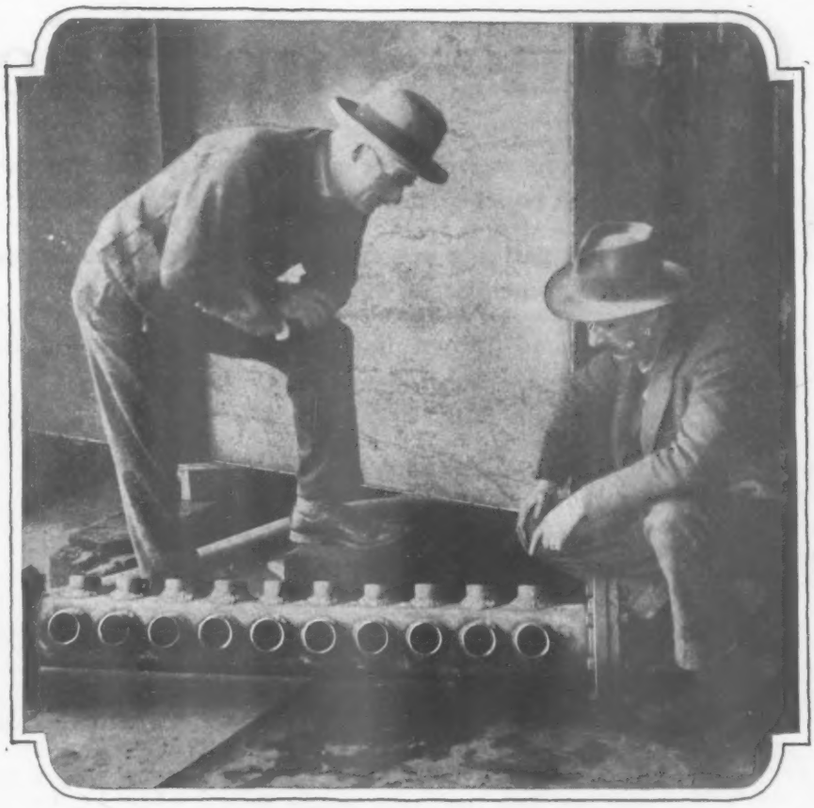

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4" Round End
4" Tee
4" Y
4" Split Bull Plug
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6" 45° Ell
6" Rt. Angle Ell
6" Lateral
6" Round End
6" Tee
6" Y
6" Split Bull Plug
8" 3 Piece Ell
8" 45° Ell
8" Rt. Angle Ell
8" Lateral
8" Round End
8" Tee
8" Y
8" Split Bull Plug
10" 3 Piece Ell
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10" Rt. Angle Ell
10" Lateral
10" Round End
10" Tee
10" Y
10" Split Bull Plug
12" 3 Piece Ell
12" 45° Ell
12" Rt. Angle Ell
12" Lateral
12" Round End
12" Tee
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8x3 Tee
8x4 Tee
12x3 Swedge Nipples
12x4 Swedge Nipples
12x6 Swedge Nipples
12x8 Swedge Nipples
12x10 Swedge Nipples
10x3 Swedge Nipples
10x4 Swedge Nipples
10x6 Swedge Nipples
10x8 Swedge Nipples
8x6 Swedge Nipples
8x4 Swedge Nipples
8x3 Swedge Nipples
6x4 Swedge Nipples
6x3 Swedge Nipples
4x3 Swedge Nipples
3x2 Swedge Nipples

CASING PATTERNS
5 3/16" 3 Piece Ell
5 3/16" 45° Ell
5 3/16" Rt. Angle Ell
5 3/16" Lateral
5 3/16" Round End
5 3/16" Tee
6 5/8" 3 Piece Ell
6 5/8" 45° Ell
6 5/8" Lateral
6 5/8" Round End
6 5/8" Tee
8 1/4" 3 Piece Ell
8 1/4" 45° Ell
8 1/4" Lateral
8 1/4" Round End
8 1/4" Tee

ODD SIZE TEES
5 3/16Cx3" I. D. Tee
5 3/16Cx4" I. D. Tee
6 5/8Cx4" I. D. Tee
6 5/8Cx3" I. D. Tee

With these curves you can make patterns for any of the above on any desired material, without the use of mathematics or drawing instruments. They will save many times their cost.

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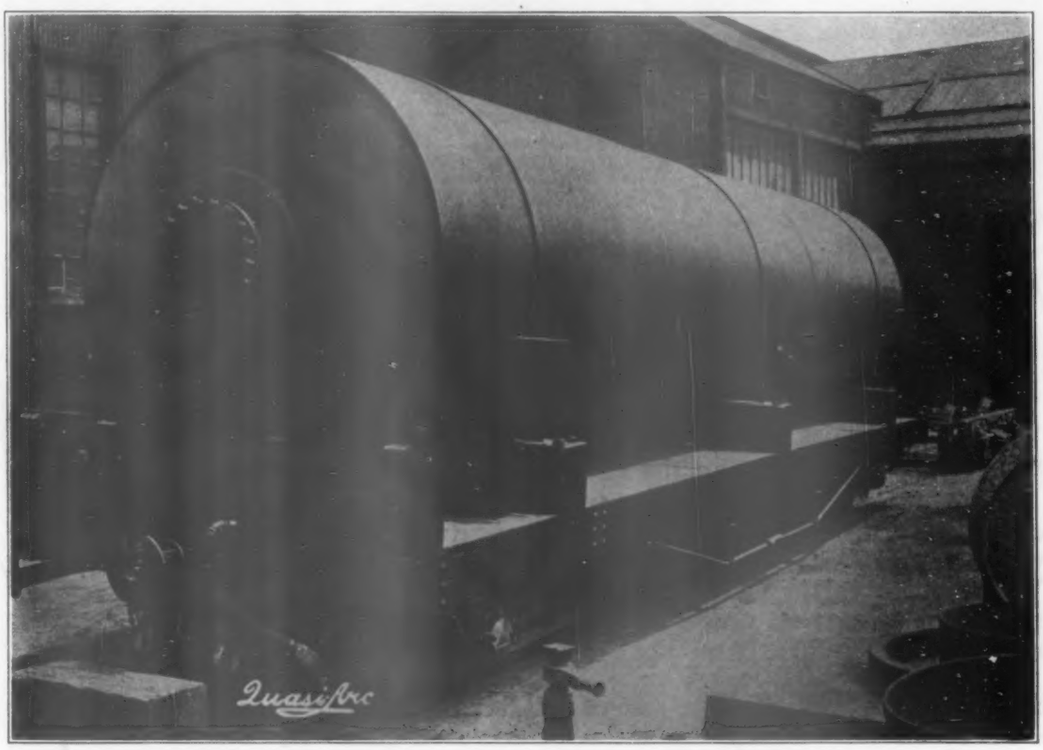

Length 30 feet; Diameter 6 feet; Plate-thickness ½ inch; Gas Pressure 160 lbs. per sq. in.

A number of Gas Storage Tanks, similar to the one shown above, were designed and built by a Railroad Company using QUASI-ARC Electrodes after very exhaustive tests were carried out giving the makers perfect confidence in the use of our products.

The reasons why we recommend that YOU should use QUASI-ARC Electrodes for this class of work are:—

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2. **High Endurance Limit of Weld Metal under Alternating Stresses.**
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Sole Manufacturers of Quasi-Arc Electrodes and Welding Equipments and Consultants in Reference to their Application.

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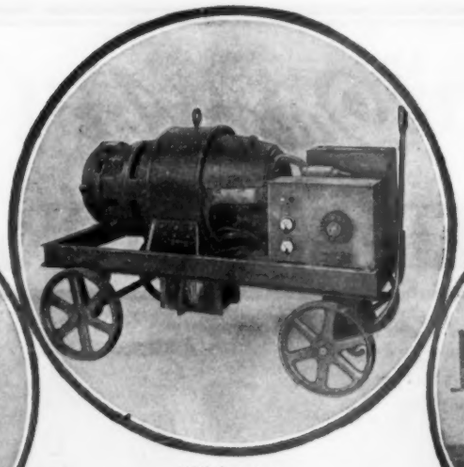
200 Ampere

This unit will operate over a wide range from 60 to 300 amperes which is the range ordinarily required in general welding service. It has a rating of 200 amperes for one hour, high continous capacity.



300 Ampere

Has a welding range of from 75 to 400 amperes. This increased capacity enables operators to handle heavy work in addition to average welding work, and is recommended for automatic service. It has a definite rating of 300 amperes for one hour, high continous capacity.

400 Ampere

Designed and constructed for extra heavy work in addition to average welding work, and for automatic service where high current and speed is desired. This unit has a welding range of from 100 to 500 amperes and has a definite rating of 400 amperes for one hour, high continuous capacity.

Now—Three Master Welders

THE speed in operation, the strength and uniformity of welds, the high efficiency over the entire operating range, the "pep" and stability, and the low maintenance costs that characterized Westinghouse Welding Sets in the past, are embodied in these three machines—plus new mechanical features which the rapidly increasing use of electric arc welding demands.

So now there is a complete line of welders available—distinct types of single operator sets for each class of work—ranging in capacity from 200 to 400 amperes.

These sets represent the latest development in welding machinery. The entire range of each machine is obtained by merely turning a single rheostat handle. They are all equipped with Linestart Motor and Linestarter—a simple and economical combination. Just push the button and the Linestarter functions, the motor starts and the machine is in operation.

The generator instantly responds to any change of voltage in the arc. The design of the Westinghouse Welding generator assures a fast, dependable machine—one that assists the operator to do more and better work.

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EDITORIAL

Proper Supervision Makes for Good Welding

THE welding industry naturally has its share of "jerry-builders," who turn out work just good enough to "get by." The results of their work have aroused opposition to welding on the part of some in whose minds welding is still on trial. The excellent record produced by countless welds in service in boilers, on high-pressure pipe lines, in steel frames of buildings, or on airplanes, is sometimes overlooked in the light of a conspicuous failure,—the work of some welder who tried to "get by."

There is just one effective means of eliminating the jerry-builder, and that is by constant and consistent supervision. In this connection, it may be well to consider here the qualifications of a good welding foreman.

One of the prime requisites is conscientiousness, and the ability to discern and encourage this quality in the operators. A conscientious amateur who will not pass a poor weld for a good one is a more valuable man than the highly skilled welder who lapses into the habit of thinking that every weld that looks good is good enough.

A good foreman is thoroughly experienced with the processes used in his shop—oxy-acteylene, arc, or resistance. He must know what makes a good weld, such as perfect fusion and thorough penetration, and must be able to recognize defects and to show the operator how to overcome them.

The foreman should be able to plan and carry out each job so as to consume a minimum of gas, current and time. He should have a fundamental knowledge of the physics and metallurgy involved in the making of a good weld, and of the composition and properties of the particular metals being welded.

Finally, the foreman should possess a personality that will win and hold the respect and cooperation of his men. With such a supervisor in charge of welding operations, the jerry-builders cannot hope to "get by."

Welding Industrial Buildings

INDICATIONS are that it will be entirely impossible to give a detailed record of all the welding which is done during the current year on industrial buildings. The practice of welding such buildings has reached a volume which will probably necessitate selecting typical jobs which illustrate important features of such construction. Looking back over the work of the past two or three years it may appear that many of the buildings already constructed have been in the nature of experiments but this is certainly not true of all of them. In a number of cases the plans for such buildings were made with perfect confidence that welding was the proper method to use in fabrication and construction, this confidence being based upon either experiment or experience. Large organizations who have in mind more or less expensive building operations during the coming year are making definite plans to use welded construction because they are completely convinced of the advantages of the process.

The Tool Was All Ready

REPLACEMENT of castings by welded steel has been one of the important advances made by the welding industry in the past two years. The manufacturer who points to a stock room full of rolled steel plates, bars, and structural shapes, remarking, "This is our foundry," puts a dramatic emphasis on the significance of this application of welding. But it is not entirely a welding operation. Many of the possibilities of welded steel, particularly the special jobs, would not be so very economical if it were not for the low cost of cutting steel with the oxy-acetylene torch. This tool has received scant attention in this connection because its advantages for cutting were so well known that it was rather taken for granted. However, the cutting torch manufacturers need not feel slighted. Their tool was ready when the job came along and there is no competitor for it. The torch maker can afford to take his reward in orders rather than glory.

The Ford Card—A Welded Wonder

DURING the automobile show season this year, the motoring public was treated to an entirely new type of industrial exhibit as guests of the Ford Motor Company. This separate show, which deserved its title of an industrial exposition, gave to the public a very complete and detailed picture of this big industry whose center lies in the city of Detroit. The significance of the show to the welding industry is that it demonstrated to such immense crowds the almost miraculous influence which welding has had in the complete transformation of the Ford line of automobiles. Engineers and factory executives were on the ground to explain to all visitors how it is that Ford officials have been able to adopt the use of electric resistance welding to the fabrication of different parts of the car so successfully, and why it would be a commercial impossibility to manufacture the same product without the use of welding. From one end of these automobiles to the other and from top to bottom it is a continual story of the ingenious use of welding to make possible the use of certain materials or to make possible the production of parts in certain desired shapes to get maximum strength and utility from minimum weight, with a minimum waste in material, and a minimum expenditure of time in production and assembly. This plant has long been known as a large user of welding but probably few people in this industry have realized the advances made by this organization in the finer applications of the process. As the different parts of the machine are studied we see again and again shining examples of what we have discussed in these columns as "Redesign Engineering." The shape, the materials, the structure and the properties of bulding parts have been entirely changed, and welding has made it possible. This great manufacturing organization has created in the minds of the public an entirely new confidence in welding as a fabrication process. It has also given to other kinds of industrial plants a shining lesson in the economic value of research, for without persistent research many of the successful welding operations in this plant would long ago have been abandoned as impossible. The economical production of an automobile which is 90 per cent steel is not only an engineering achievement but probably one of the greatest welding achievements in the history of the process.

Optimism Is the Order of the Day

IF ANY are inclined to believe that any one of the welding processes is nearing its limits of application, they need only to listen in at some of the association conventions within the industry to catch the spirit of optimism regarding the future. In fact, much of the enthusiasm displayed at these meetings has come from the users of welding—gas companies, manufacturers of heavy machinery, railroads, and piping contractors, to name only four fields in which welding is forging ahead on its own merits. Paralleling the growing acceptance of welding as standard procedure is the development and improvement of the processes themselves, both in technique and equipment. Pessimism and rapidly accelerating growth cannot live in the same camp.

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Welding Wire

In the large important steel works, shipyards, industrial plants, automobile shops, railroad shops and repair shops, Roebling Welding Wire is giving satisfactory service and demonstrating its efficiency and reliability. Roebling Electrodes are positively uniform in quality throughout the same shipment and throughout all shipments. They make the strongest and toughest welds with the least amount of trouble in welding. Roebling Welding Wire conforms to specifications of the American Welding Society.

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Navy Welds Aerial Practice Bombs

Original Design Calling for Lock Seams and Soldering Abandoned for Cheaper and More Dependable Welded Construction

By O. P. Murry* and C. N. Grubbs†

THE manufacture of 100 lb. aerial practice bombs was undertaken recently on a large scale for the Bureau of Ordnance. The methods of manufacture present some unusual features in this class of work and it is therefore believed to be of interest to describe these methods for possible adoption in the case of similar work.

The original design of the bomb shown in the photograph contemplated the use of galvanized sheet metal

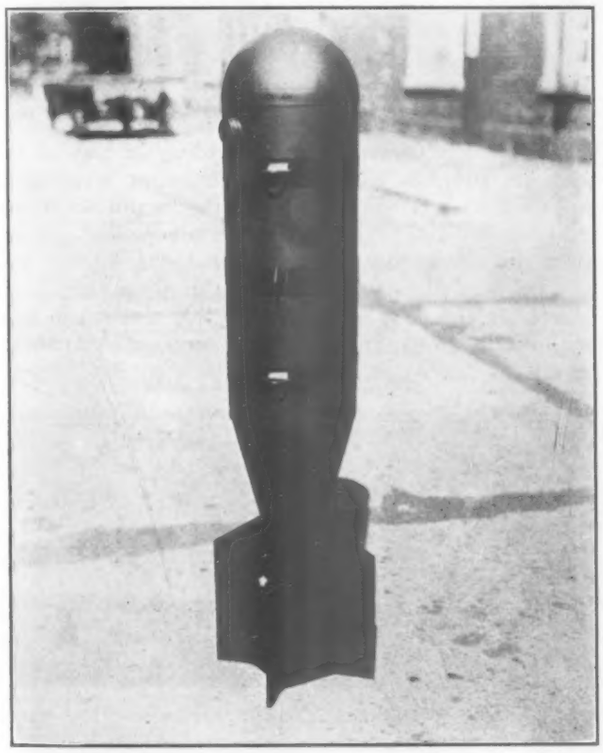


Fig. 1. 100-pound Aerial Bomb Fabricated by Seam, Spot and Gas Welding.

with lock seam and soldered construction. The thickness of metal forming the head, body and cone is 22 gauge. A study of the proposed design indicated that it permitted of ideal seam and spot welding and this form of construction, with black sheet metal, was proposed and adopted. The bombs are filled with water when used. It was therefore necessary that they be watertight. The method of construction was ideal for this purpose also since very few leaks are found in a properly seam welded joint. To prevent corrosion of the black metal it was proposed to coat thoroughly with a good baking varnish and to bake to a hard finish.

The various parts required for each of the bombs are shown in photograph 3. Since the number of bombs manufactured on the original order was 5,000 it was practicable to obtain the necessary dies for these parts. The sub-assembly of the parts was completed prior to assembly of bombs wherever practicable so that the major job of assembly once started was continuous. Some of the various sub-assemblies and the operations leading up to these assemblies are shown in the illustrations. The most interesting of these operations and those which resulted in the greatest savings are those of assembly of the bodies by seam welding.

(a) The body of the bombs consists of three parts: the semi-spherical head; the cylindrical section and the flat bottom. The head is of 22 gauge deep drawing steel, drawn cold in one operation, trimmed, redrawn to shape and spun clean in a lathe. The cylindrical section was sheared to size, rolled, seam welded, body punched and flanged for nozzle, and nozzle sweated in

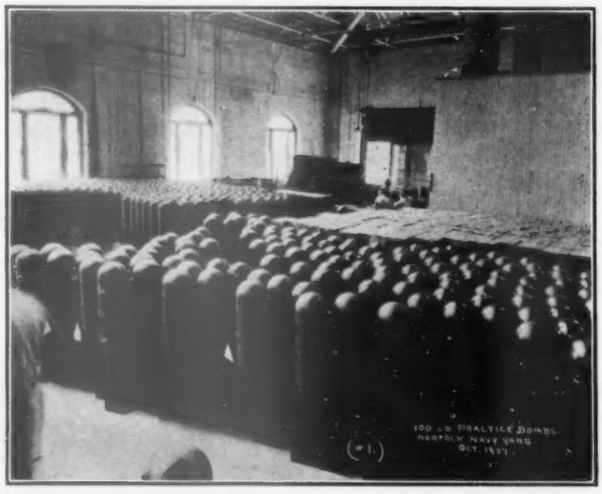


Fig. 2. Production of These Bombs is at the Rate of 300 a day.

place. The bottom was sheared and flanged in one operation. Photograph No. 5 shows the assembly of the body entirely by seam welding. Two welding machines were used for this work; Type Seam 3 No. SOKVA and Type Seam 436 No. KVA150, as manufactured by the Gibb Welding Machine Company. Production of completed bodies was approximately 300 per eight hour day from these machines and the tightness of seams was considered exceptional. Each body was tested for tightness by completely filling with water.

(b) A very material saving was made by using a standard five gallon varnish can nozzle. The body was punched and flanged for this nozzle; the nozzle soldered in place as shown.

(c) Sub-assembly of cone and vanes was by means of spot welding; a rigid fixture being employed to insure accuracy.

The final assembly of body and tail sections is shown in photograph. The joining together of these two parts was accomplished by tack welding, with the use of a special fixture to insure accuracy of overall length

*Master Sheet Metal Worker, Norfolk Navy Yard.
†Assistant Shop Superintendent, Norfolk, Navy Yard.

and other dimensions which were checked on one of every 25 bombs as shown in photograph No. 8.

The painting of the interior of the body was necessary after assembly on account of welding which would have destroyed the painted surface. A make shift rig as shown in No. 6 was employed; about two gallons of paint being admitted from gravity tank; nozzle cap placed on nozzle and body rolled down incline and paint discharged to tank below the trough and then pumped automatically to the gravity tank to be used again. Exterior painting was accomplished by spraying; a high grade baking varnish being used. The paint was baked to a hard finish in an electric oven at about 300° F.

Each bomb was fitted with three carrying bands as shown. These bands were assembled complete, painted by dipping and installed in place after painting of bomb.

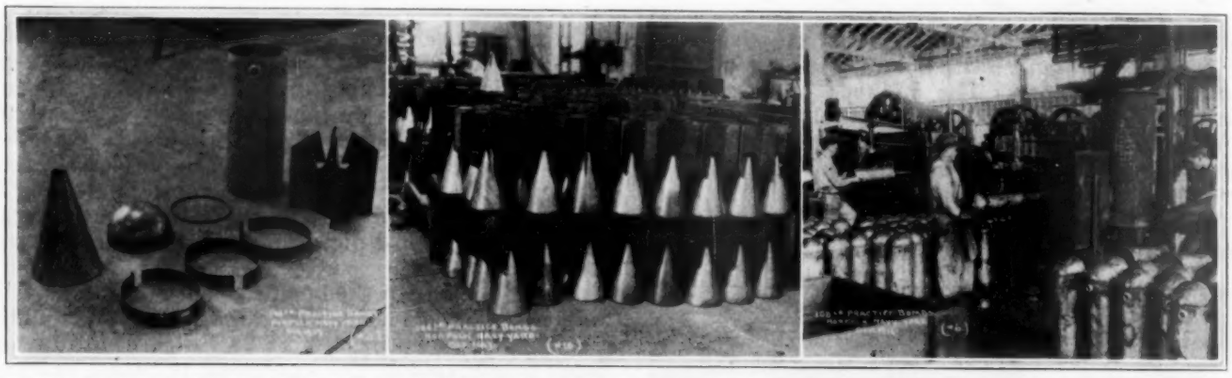


Fig. 3. Parts Required For One Bomb. Fig. 4. Sub-Assembly of Cone and Vanes, Spot Welded. Fig. 5. Seam Welding of Cylindrical Body.

Norfolk Navy Yard manufactures approximately 50,000 10-gallon paint drums annually with bodies of 20 gauge material and tops and bottoms of 16 gauge. The body of these drums is assembled complete by means of seam welding and is tested under air pressure to meet I.C.C. requirements to 15 lbs. 1 sq. in. Leakage in any part after welding is found in less than 1% of the drums tested and is of such a minor nature usually that it is easily corrected by rewelding in way of the leak. In addition to paint drums seam welding is employed to a large extent in the manufacture of metal waste baskets, soda-line containers and several other similar products. Considerable progress has been made with seam welding aluminum and it is expected in the near future to use this method in connection with the manufacture of aluminum sheet metal articles.

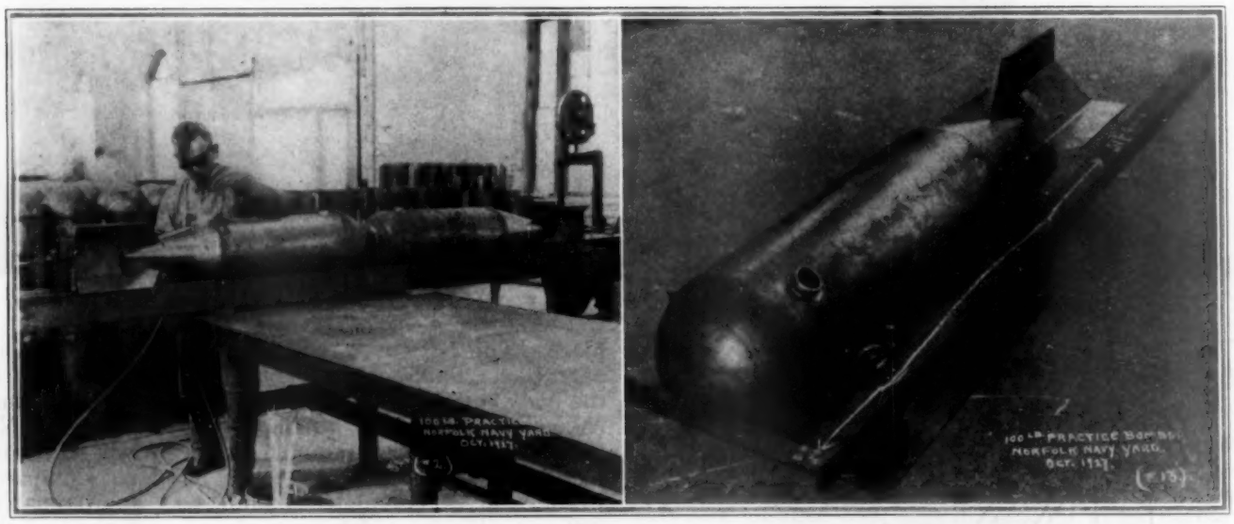


Fig. 7. Oxy-Acetylene Welding of Final Assembly. Fig. 8. Dimensions Checked After Welding to Insure Accuracy.

The production and shipment of these bombs was at the rate of approximately 300 per diem. Photograph shows completed bombs ready for packing.

The savings realized on this job alone over the cost of the original proposed construction, if galvanized metal, lock seamed, had been used, were sufficient to pay for the original cost of the Type Seam No. 436 No. KVA150 welding machine which was new and used for the first time on this job although not purchased solely for this purpose.

Seam welding is being used extensively in connection with the manufacture of sheet metal articles. The

INSTITUTE OF METALS REPORTS GROWTH DURING 1927

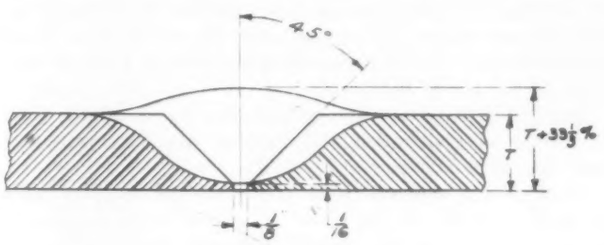
During the past year the membership of the Institute of Metals increased from 1801 to 1903. It is anticipated by the council that the present year— the twentieth of the Institute's existence—will witness the enrollment of the 2,000th member. An election of members took place Wednesday, January 18. Particulars of membership are contained in a booklet descriptive of the work of the Institute which can be obtained from Mr. G. Shaw Scott, M. Sc., Secretary, 36 Victoria Street, London, S. W. 1. The annual general meeting of the Institute will be held in London on March 7-8, and the autumn meeting in Liverpool on September 4-7.

Welding of Power Plant Piping*

Research of Pipe Fabricator Has Developed Designs and Procedure Which Insure Satisfactory Results on Every Welded Installation

By A. W. Moulder†

THIS presentation is intended to cover the subject as it relates to the welding of power plant piping autogenously only and is not intended to relate to the forge or hammer welding process. The discussion is also based upon the use of the oxy-acetylene rather than the electric-arc process. This is primarily for the reason that the former process is the one which has been found most practical for work of this kind, probably due to the fact that the welding of power plant piping is not a production problem, but rather almost every order presents somewhat different "cut and fit" problems. The ability of the same operator to use the torch for both cutting and welding has no doubt had a considerable bearing on the fact that this process has



BUTT WELD

SKETCH N° 1

been the one most generally adopted for this class of piping work. Furthermore, our own research work and most of the research work with which the writer is familiar and which deals with the particular problems involved has been in connection with the oxy-acetylene process. It has been our experience, however, that where the electric-arc process has been employed by us, the same general methods of prparation of materials, training and testing of welders and testing of finished products have been likewise employed and as far as we have been able to determine without going into the same research work with equally satisfactory practical results.

The welding of power plant piping is unquestionably growing in favor steadily. There are a number of basic reasons behind this growth which briefly are as follows:—

1. Elimination of screwed and flanged joints with resulting lower maintenance costs.

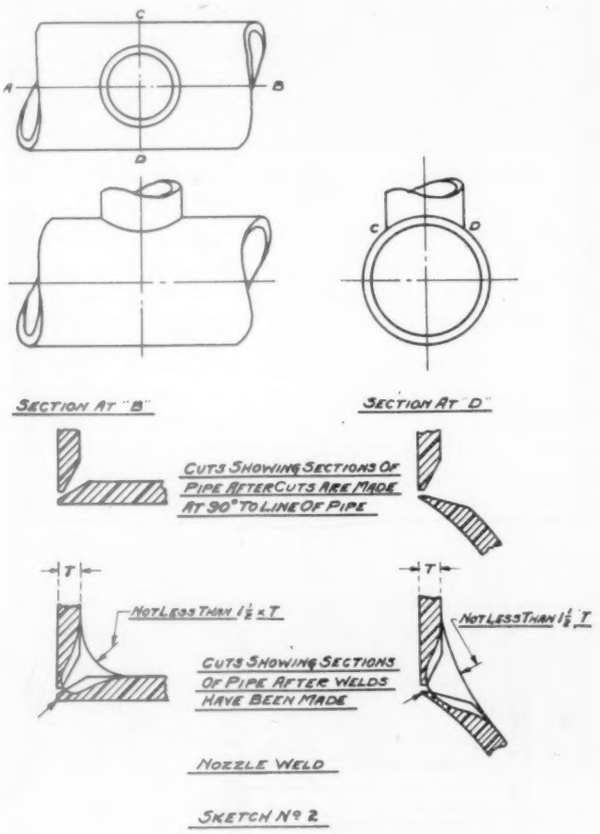
2. Lower first cost, especially where a multiplicity of connections are made to a pipe in a limited area such as in case of headers.

3. Decreased weights—especially where welded steel is substituted for large cast fittings.

4. Continuity of insulation is permitted by elimination of flanges, with resulting increased efficiency and decreased cost of insulation.

5. Improved service in erection, especially where field welding is employed and in overcoming the time required for the making up of "special" or odd shaped fittings.

All of the above advantages were of course recognized in the early days of pipe welding. The importance of power plant piping, however, in that a failure not only endangers the life and limb of employes, but cuts off a most important service, has had a just deterring effect upon the growth of welding for this class of work as compared to its growth in other classes of piping work. A number of the more responsible concerns dealing in the fabrication and erection of power plant piping have been furnishing piping of this class for many years and the record in connection with these materials has been so excellent as to gradually win over the



NOZZLE WELD

SKETCH N° 2

confidence of engineers and purchasers until today welded piping is growing in use for power plants more rapidly than at any other period in its history. The writer has been unable to learn of any accident ever having been caused by a failure in welded piping made by any responsible pipe fabricating concern.

Our own concern has been fabricating welded piping for nearly eighteen years, and during that period has put into service hundreds of thousands of welds in steam pressure piping and without a single failure having come to our knowledge. Today it is not unusual to be called upon to fabricate welded piping for 400 lbs. working pressure of superheated steam and total temperature up to 750° F.

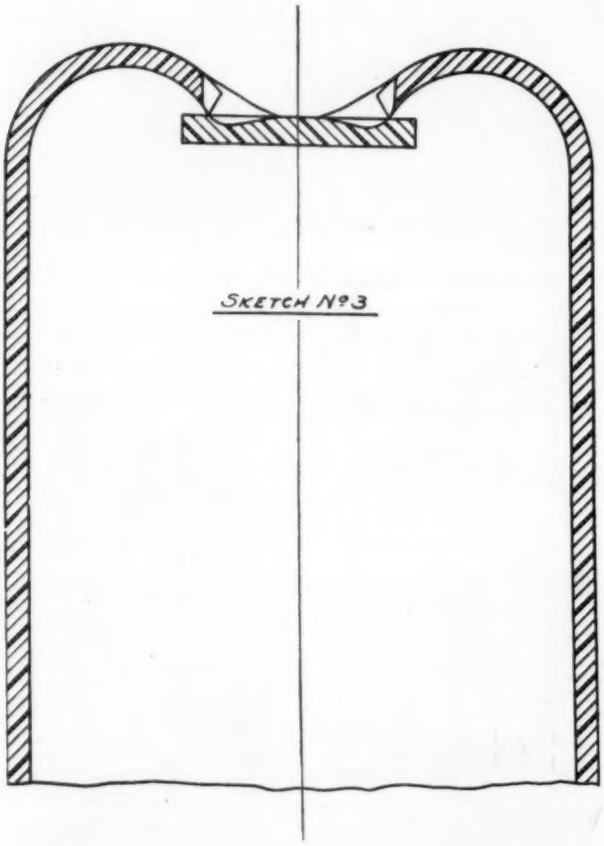
*Paper presented at joint meeting of Metropolitan Section of American Society Mechanical Engineers, Am. Welding Society.

†Manager, Heating, Power and Industrial Piping Division, Grinnell Company, Inc., Providence, R. I.

Therefore, I repeat that the record behind welded piping made under proper management is responsible for its growth in favor more than any one of the apparent inherent advantages.

On the opposite side the question naturally arises, why hasn't welding of power plant piping grown to a point of the almost exclusive use to which its many advantages would seem to indicate it is entitled? The answer is today just the same as it was 10 or 15 years ago. What assurance has the purchaser that the welds are properly made? The answer to this has been written into your records many times, but resolves itself largely into the one word: Management. As applicable to welding of piping this includes or is composed of several parts which have also been well covered previously.

1. Proper materials.
   (a) basically as to their inherent qualities.
   (b) artificially as to their preparation for the work involved.
2. Proper tools.
3. Proper methods and instruction.
4. Proper testing of welders.
5. Proper test to see that the failure of the human element does not destroy all of the values of the preceding factors.



It is not my intention to review the details under each of these headings because they are a matter of record, but simply to touch on those phases of the problems which have developed comparatively recently, and will endeavor to explain the reasons or research work which are responsible for or substantiate the practicability of these developments.

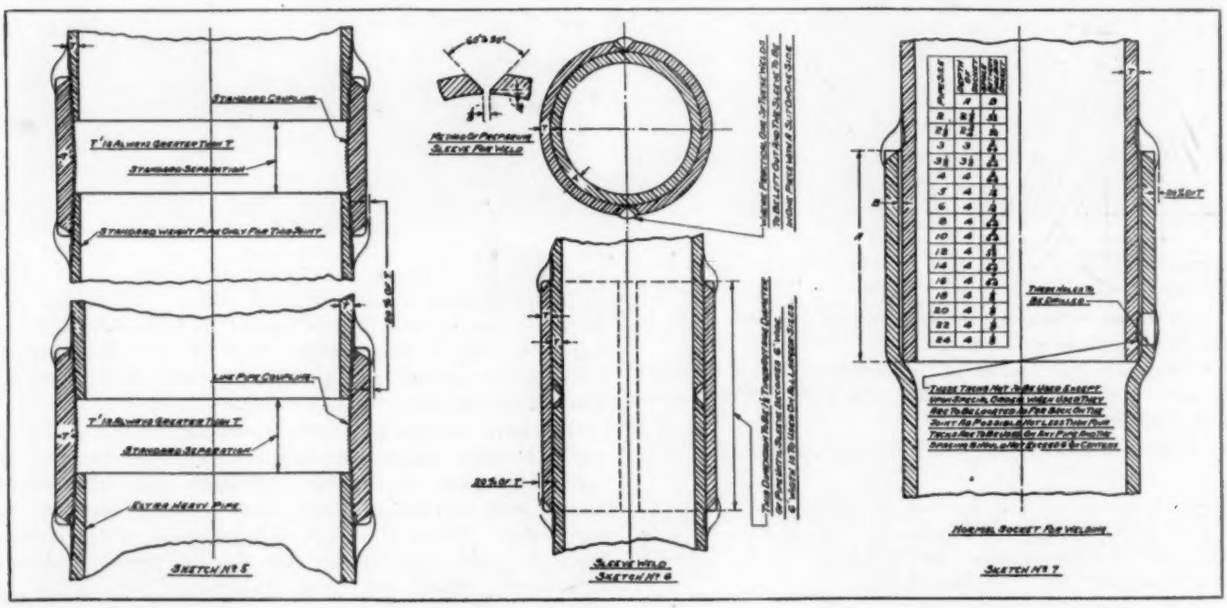
First, under the preparation of materials. Sketch No. 1 is the basis of most welds, either for butt welding of two pipes together or for the making of special fittings, etc. The preparation as shown is the same as the generally accepted standard excepting that the spacing between the bottom edges has been increased from $\frac{1}{16}$" to $\frac{1}{8}$". Inspection of sections cut from welds have shown a tendency for these bottom edges to over-lap after the welds had cooled and contracted. The wider spacing has shown a better condition on the inside of the pipe.

Sketch No. 2 covers the preparation for a nozzle weld. This style of preparation and welding has become a generally accepted standard.

Sketch No. 3 shows a weld at the end of the pipe when the weld is made in the shop. The end weld or plug in the end of the pipe has entirely different stresses than any other weld in view of the total pressure over the area involved. This type of joint provides extreme safety in that the plate is entirely inside of a rolled joint.

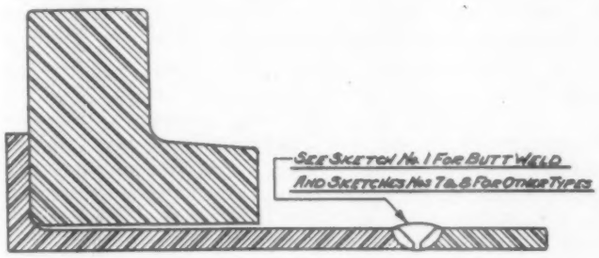
Following through the sketches shown covering various types of welds, attention is called to the shape of the fillets. The fillets should in all cases be so made as to provide a thickness of fillet material in excess of the pipe materials.

Sketches No. 5, 6 and 7 show various types of welds in common use for long lines of piping. Particular attention is called to sketch No. 7 which illustrates two types of welds, which later in illustrating tests are mentioned



as Normal Sockets, illustrated on the left half of the sketch, and Normal Sockets with Pins illustrated on the right half of the sketch.

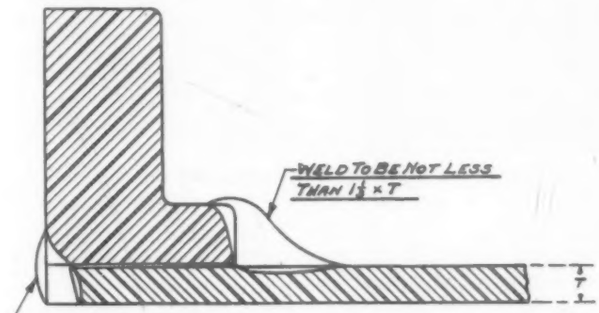
Sketches No. 9, 10 and 11 illustrate various types of flange welds. The use of flanges per sketch No. 9 are preferable for field welding on account of the long skirt which prevents any warping of the flange sufficient to make it necessary to do any refacing.



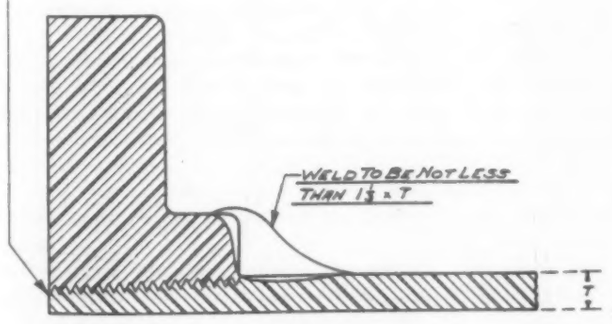
PREFERRED METHOD FOR ATTACHING FLANGES BY WELDING

SKETCH Nº 9

Seemingly digressing, let us consider for a moment the effect of locked instresses due to uneven heating and cooling of the weld zone. Much has been said in a general way on this point, but little has been actually proven specifically as to its effect in connection with pipe welds.



SKETCH Nº 10



SKETCH Nº 11

About two years ago we set about to find out what we could about the effect of these internal stresses upon the over-all strength of the pipe joint. Strain gauge tests were made in connection with both annealed and unannealed sections of 4" pipe and a brief summary of the results are shown by Sketch No. 12.

Sketch No. 12. These strips, ¾x3" long, were cut from the pipe at points indicated. The results are relatively unimportant except that they show that the entire strains are in compression and they show further that there are relatively different strains in unannealed pipes. This method of testing was not carried forward to reach any definite conclusions.

We knew that we could cut coupons from welded pipe and with welds made by trained welders which, when pulled, would break outside the weld zone, but this did not answer that continually recurring question about the effect of internal stresses because when the coupon is cut from the joint,

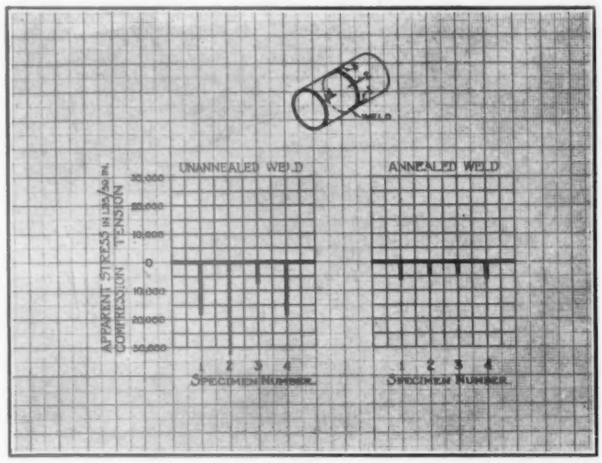


Fig. 12. Results of Strain Gauge Tests on Annealed and Unannealed Sections.

the mechanical stresses are released. We, therefore, decided that the most practical test to determine this would be to pull the pipe with the welds in its entirety, or in other words pull full section samples. This work was started more than a year ago with 4" pipes.

Fig. No. 13 shows a picture of some of the early tests made in connection with 4" samples. The pulling machine used required flanges for bolting. It was impossible to develop flanges even screwed through and back welded as shown by this sketch which would develop as great strength as the intermediate butt weld or the pipe itself.

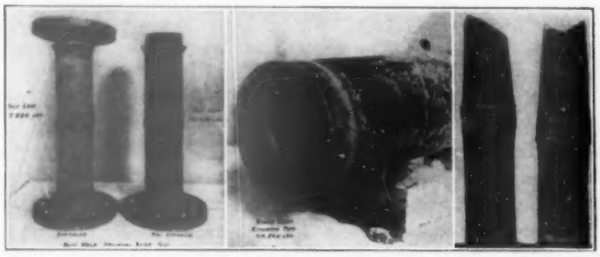


Fig. 13. Flanges Used in Early Tests. Fig. 14. Result of Using Ordinary Lap Joint for Pulling Tests. Fig. 15. 8-in. Pipe Made Up With Socket Welds Shown in Sketch No. 7.

Fig. 14 shows what happened when an ordinary commercial lap joint was used in connection with these pulling tests. The lap joint was drawn right through the flange as shown. It was not until we made heavy laps, now known as the Grinnell Triple-Ex XXX Line, that we could develop sufficient strength in a flanged joint to break either the pipe or the weld intermediate.

The foregoing illustrations are interesting only by way of showing what led up to the later tests.

We decided, after a number of tests of both annealed and unannealed sections that the 4" pipe did not represent the worst condition as regards the internal stresses and therefore shifted our work to another laboratory capable

of pulling larger pipes. The work thus started created considerable interest and was carried on by other parties on a much larger scale and I am privileged through the courtesy of the National Tube Company to show you an advance report of the results of a long seris of tests along this line.

Fig. No. 15 shows a summary of three types of welds which were tested. It will be noted that even those pieces which broke in the welds themselves held an average tensile load practically equal and in many cases in excess of the pieces which broke entirely outside of the weld zone. It might be added that no pieces in the entire test broke at a point which indicated low strength.

Fig. No. 16 indicates two pieces of 8" pipe made up with

RESULTS OF TESTS ON OXWELD JOINTS MADE ON ONE SIZE OF PIPE BUT WITH DIFFERENT TYPES OF JOINTS.

PIECES TESTED	TYPES OF JOINTS	BROKE OFF IN WELDS PCS.	BROKE OFF IN WELDS LOADS IN TONS	BROKE OFF IN PIPE PCS.	BROKE OFF IN PIPE LOADS IN TONS
	Pipe 4" O.D. x .1875" thick				
6	Normal Sockets	-	-	6	67.000
6	Socket & Pins	-	-	6	67.833
6	Butted Joints	-	-	6	69.000
	Pipe 8" O.D. x .1860" thick				
6	Normal Sockets	-	-	6	140.160
6	Socket & Pins	-	-	6	140.160
6	Butted Joints	1	147.000	5	131.800
	Pipe 12" O.D. x .2800" thick				
6	Normal Sockets	1	286.00	5	270.400
6	Socket & Pins	1	262.00	5	252.000
6	Butted Joints	1	280.00	5	263.400
	Pipe 16" O.D. x .3125" thick				
6	Normal Sockets	4	426.80	2	420.000
6	Socket & Pins	6	377.83	-	-
6	Butted Joints	5	431.20	1	446.000
72		19		53	

Fig. 16.

normal socket welds as shown by sketch No. 7 and which broke entirely outside of the weld.

Fig. No. 17 indicates two pieces of 12" pipe made up with socket welds with pins, also as illustrated by sketch No. 7. By carefully noting the picture it will be found that cracks developed around the pins due to the extra strains set up in the joint by same. These cracks developed long before the pipe itself or the joint could be broken.

Fig. No. 18 shows two pieces of 16" pipe made with a regular butt weld as shown by sketch No. 1. One of these it will be noted broke entirely outside of the weld zone and the other one directly in the weld. Piece marked No. 6517, however, broke at 446 tons pull and piece No. 6520 broke at 448 tons.

Fig. No. 19 shows a screw coupling back welded in 14" pipe as shown by sketch No. 5. This shows one of the earlier tests not included in the above series and is included in the illustration merely to bear out the fact that this type of weld is a strong and safe weld.

Beyond what details were learned from these tests they show that when properly designed for reinforcement and when made by properly trained welders, these joints in varying types can be made to overcome whatever internal stresses are locked in as none of these joints were annealed.

Going back again to the matter of design and shapes of fillets. The importance of building up the welds as already mentioned was one of the things learned in the preliminaries to this remarkable set of tests.

Another thing developed in these preliminaries was the shape of the welded fillet. To approach perfection, the lines of force should be kept as nearly straight as possible. This means making the shape of the fillets gradually sloping without abrupt turns, otherwise under stress the sharp corner checks, gradually throwing the stresses further inward toward the pipe material itself. This accounts for the shape of the fillets as shown.

By referring back to the sketches covering the preparation of various types of welds, it will be seen what is meant by the building up of fillets and the design of what might be called stream line effects in same.

The writer has had no cause to change his original ideas as to the efficiency of the plain butt weld as compared to mechanically reinforced types, and it will be interesting to note that the results show somewhat greater strength for this type of weld over others in the series of tests illustrated. It is the writer's belief that adding straps or reinforcements complicates the stresses which are as proven by these tests now well harnessed or overcome by careful design and workmanship. The only portion of this series of tests which in any way indicate this, however, are the relative tests of normal socket welds as compared with socket welds with pins, the latter usually fracturing around the pins before either the joint itself or the pipe was fractured. In other words, the addition of the pins apparently added nothing to the over-all strength of the joints and detracted something in that a leak was caused to appear around the pins under comparatively lower tensile pull.

Going back again to the question of "management":—

Instruction of welders has been many times emphasized and full data on this subject is available. The testing of welders is of extreme importance and in addition to having coupons pulled at regular intervals, we have found another test very valuable both to impress the welder with what his work must be made to accomplish and as a practical check upon the general quality of welding. This test is the final practical one used for checking either oxy-acetylene welders or electric-arc welders.

Fig. No. 20 illustrates a piece of pipe tested in accordance with our standard instructions which are as follows:—

"Each welder before being considered qualified to operate must pass the following prescribed test.

1. Prepare two pieces of 6 inch standard weight pipe, each end beveled as per our standard and with extra heavy lap joint flanges on the opposite end of each piece to which must be bolted extra heavy blind flanges with a test connection.

2. The welder must then make a complete butt weld according to our standard specifications. This completed piece must be tested to 750 lbs. hydraulic pressure and thoroughly hammered around the circumference of the weld while the pressure is applied.

3. The sample must then be placed on our bending table with a bending shoe located approximately 6 inches back of the center of the weld and then pulled cold until the pipe collapses practically flat.

4. After this is done the weld and pipe are to be examined for any visible cracks and, if the condition of the pipe permits, it is to be again placed on the test rack and hydraulic pressure applied to be certain that there are no cracks in the weld.

A welder who has successfully passed this test will be considered qualified for independent work on our welded piping.

In sketch No. 20, point "A" represents the weld in the piece and "B" represents the point at which the bending shoe was located. In this photograph the piece has passed through its second testing and has started to crack at point "B" under approximately 500 lbs. pressure.

Finally, the rigid enforcement of the test of the finished product insures not only the purchaser of receiving materials suitable for the purpose intended, but also is insurance for the fabricator that "management" is functioning and the operators are performing to the requirements. Our required test for high pressure steam piping when welded is as follows:—

"Welded piping material will be subjected to a hydrostatic pressure of three times the maximum allowable working pressure. Welds shall be hammered while under test, the hammering to be done all around the weld on both sides with a hammer weighing from 2 to 6 lbs., depending on the size of the pipe, and the blows shall be as heavy as possible without deforming or injuring the material."

A question is often raised as to the behavior of welds under high pressures and temperatures. With increased steam pressures, the piping materials are correspondingly increased in weights. The proper design of welds necessarily provides for a proportionate increase in the thickness of fillet and building up of the welds so that the relative strength of the joint is maintained. Recently there was a most interesting article written in your records as a preliminary report on the subject of "Welds and Elevated Temperatures," in which one of the conclusions reached after

Fig. 17. 12-in. Pipe With Socket Welds With Pins (Sketch 7). Fig. 18. 16-in. Pipe With Butt Weld (Sketch 1). Fig. 19. Screw Coupling Back Welded (Sketch 5). Fig. 20. Pipe Tested According to Standard Instructions.

some very excellent research work was: "As far as ultimate strength is concerned a strong weld cold is in general a strong weld hot." This conclusion would indicate that welded joints made to proper design are just as safe proportionately when used in connection with the high pressures and temperatures encountered in the modern public utility power plants as they have been found to be by years of trial and experience operating under the lower pressures.

It seems highly probable that as usual actual practice will demonstrate as it is now already doing in higher pressures and temperatures the practicability of carrying on with progress in this field while we follow with research work substantiating the correctness of those practices. There remains yet to be done in this field of research the collection of data relating to the strength of welds under torsional strains. In actual practice it has been proved through years of actual service in pipe bends and at strategic positions in pipe lines where expansion and contraction strains and vibration are most vicious that properly made welds are altogether safe.

Engineers responsible for the piping going into these so called super-power plants realize that they are dealing with a problem where a single failure may be of tremendous import. Therefore, they can only be commended if at times they seem extremely rigid in their specifications and over careful as to the ability and integrity of the pipe fabricator.

LATEST METHODS OF WELDING TAUGHT AT SAN FRANCISCO SCHOOL

The opening of the California School of Welding at 163 Fell Street, San Francisco, several months ago has provided manufacturers of iron and steel products an ideal opportunity to train their own mechanics in the newest and most economical methods of fabricating parts in the steel and iron industries.

The school was established to train capable welders in order to meet the demand for skilled employees created by the rapid growth of welding in the manufacturing industries during the last few years.

The fact that there is a saving in production costs in nearly every instance has led to the adoption of the process by many manufacturers. As the extent of the reduction in production cost depends to a large extent upon skilled supervisors and operators there has been a consequent growing demand for skilled welders.

It was to meet the increased demand for expert welders that the California School of Welding was opened by E. R. Chinberg and J. A. Roberts, both of whom have had a long and varied experience in the welding field, Mr. Chinberg's experience being primarily in the electric welding field and Mr. Robert's in the oxy-acetylene field. Both are engaged in the welding equipment business and consequently are in direct touch with the newest demands and methods in the welding field.

Instruction in the school is under their personal supervision and a number of students have already completed the course.

In a number of instances large manufacturers have provided for instructional courses at the school for their superintends, supervisors and foremen so that they would have a thorough understanding and knowledge of the welding trade and would be better able to supervise their own work, and make use of the latest methods.

A large number of unskilled workmen have also taken advantage of the opportunity to learn a trade and greatly increase their earning power. A number of graduates from the school are now employed in some of the largest shops in the San Francisco Bay District.

The purchase and installation of the equipment at the school has been carefully planned so that all classes of work could be taught. A number of complete oxy-acetylene welding outfits, and also oxy-acetylene cutting and city gas and oxygen cutting outfits, machine cutting torches, and other equipment have been installed. In the electric welding line a number of each of the two distinct types—alternating current and direct current types—were installed.

To complete the course the student is given instruction and practice on all phases of welding. Regular day classes are held and night classes on Monday and Friday nights.

C. G. M. A. HOLDS FIFTEENTH ANNUAL MEETING IN NEW YORK

Production and distribution problems were treated by specialists in the various phases of compressed gas manufacture at the fifteenth annual meeting of the Compressed Gas Manufacturers' Association held at the Hotel Astor, New York City, on January 23rd.

In his report to the convention the secretary, Mr. F. R. Fetherston, spoke of the growth of the Association during the past year, in spite of the consolidation of several member companies into one company. The secretary also spoke of the service rendered to members through the arrangement the Association has with the transportation lines whereby gas cylinders lost or gone astray are indentified and returned to their owners. About six hundred inquiries were received during 1927, and with half a dozen exceptions every cylinder was returned to its proper owner. It is expected that similar arrangements will be made with the Canadian carriers.

The Test and Specification Committee reported progress made in the determination of a formula for ascertaining the effective wall thickness of cylinders. The desirability of having such a formula proved to the satisfaction of all parties concerned has resulted in an arrangement whereby a given number of cylinders are to be tested in the regular way at time of manufacture and then shipped successively to various plants and testing laboratories where similar tests will be conducted. The results will be compiled by the committee to establish the values of the variable factors.

This committee also reported progress in the standardization of valve threads, with the accumulation of information on the type of outlets now in use in each industry, and is working on means of overcoming the objections raised to recommendations in the case of the oxygen valve outlet.

In spite of certain disagreements in the matter of application of welding to the construction of pressure vessels, the committee has settled these disagreements to the satisfaction of all concerned, incidentally leading to a better undersanding between the various committees and a better spirit of cooperation.

After giving serious consideration to the matter of tests in the United States on cylinders made in foreign countries, a report was made by the Cylinder Manufacturers' Committee recommending that there be no changes made in the regulations or specifications affecting tests on cylinders made in foreign countries.

The fact that the Acetylene Committee has not been called upon to discuss any subject of major importance during the year is indication that all is well within the industry.

Following is the program of the open sessions of the meeting:

10:30 A. M. to 12:30 P. M.

1. Address of Welcome—President John C. Minor.
2. "Improving the Physical Properties of Steel by Testing Beyond the Elastic Limit"—Dr. E. C. Langenburg, Metallurgist, Watertown Arsenal.
3. "Corrosion"—Mr. C. E. MacQuigg, Union Carbide and Carbon Research Laboratories, Inc.

12:30 P. M. to 2 P. M.

Luncheon—Hotel Astor

2 P. M. to 3:30 P. M.

5. "Sound Industrial Marketing"—Mr. Merritt Lum, The McGraw Hill Publishing Company.
6. "Dry-Ice"—Mr. J. W. Martin, The Dry-Ice Corporation of America.
7. "The Fire Hazards of Methyl Chloride as a Refrigerant"—Mr. Thomas Coyle, The Roessler & Hasslacher Chemical Co.

New officers elected for next year are:

President—H. S. Smith, Prest-O-Lite Co., Inc.

First Vice-President—P. Samuel Rigney, Roessler & Hasslacher Chemicals Co.

Second Vice-President—H. M. Hooker, Hooker Electro-Chemical Co.

Secretary-Treasurer—Franklin R. Fetherston.

LINCOLN ELECTRIC DEVELOPS STEEL CONTAINER FOR SHIPPING WIRE

The traditional method of wrapping welding wire for shipment in burlap has been abandoned by the Lincoln Electric Company in favor of a welded steel box with wooden ends. These boxes are made up by forming the rectangular blank of sheet steel and welding the edge in a home-made jig with the carbon arc, the latter operation requiring just 0.48 min., including getting the box from the skid, clamping it in the jig, welding and piling again. After the can is loaded, wooden ends are nailed in. These boxes will stand almost unbelievable abuse and will preserve the wire in perfect condition, which is especially desirable where a coated wire is to be shipped. The steel box has a further advantage over the old burlap packing in that it is moisture proof, and is comparatively cheap.

Welding Trusses for Industrial Buildings*

The Determination of Definite Strength Values for Structural Welds Make It Possible to Design Welded Trusses with Confidence

By Andrew Vogel†

THE assembly of steel members into the form of trusses and frames involves two fundamentally different types of fastenings; namely, pins and welding. The pin type fastening can be separated into three kinds—pins, bolts and rivets. The welding method can be divided into three distinct types—mechanical resistance, and fusion welding. In this talk fusion welding alone will be discussed, with particular reference to electric arc welding. It will be understood, therefore, that in using the term "welding" the speaker is definitely confining himself to that form of welding which

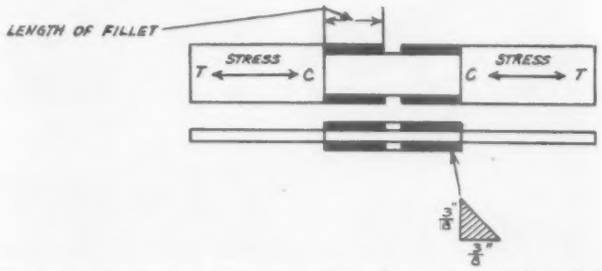


Fig. 1. Design of Test Specimens, With Shear Plane Indicated by Triangle.

consists of striking and maintaining an electric arc between two electrodes, one electrode being a metallic rod and the other being the junction point of two surfaces to be connected. The metallic rod is melted away and deposits a fillet between the two surfaces to be connected, and in the process fuses and welds together the two surfaces immediately adjoining. With this definition it is possible to immediately confine the talk to the problem involved in welding steel trusses.

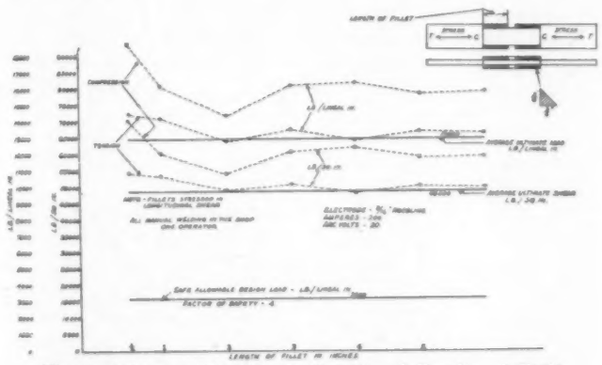


Fig. 2. Diagram Showing Uniformity of Results of Tests.

It is, however, well to mention that the problem itself would never have arisen had it not been obvious to engineers that tension members of pin connected structures were uneconomical due to the necessity of neglecting in design calculations the strip of metal the full length of the members which is located between and is of same width as the pins, and had there not been frequent complaints about the noise of riveting steel work. If then there are two important incentives to cause engineers to study the design of buildings for the purpose of applying welding, and both of these incentives are directly or indirectly measurable in dollars then we are certain that the problem will be pursued to a satisfactory conclusion.

The riveting of large buildings in our cities has been the source of much complaint. Boards of health and health commissioners are frequently besieged with complaints regarding the unbearable noise of the steady hammering of riveters at work. All of us have experienced the annoyance of riveting hammers so if anything can take its place which will produce satisfactory results, even though the expense be slightly

Fig. 3. Constructing Truss in Trenton Plant of American Bridge Company.

higher, we are justified in making the substitution.

The reduction in the amount of steel required for trusses that are arc welded in comparison with trusses that are riveted is only a problem in mathematics. Calculations of the weights of welded and riveted trusses for the same load indicated a saving in weight of between 12 and 15 per cent in favor of the welded trusses. Naturally these calculations indicated that engineers were justified in making a diligent study of the entire problem in order to obtain these economies in steel work both for the present and for the future. If no other benefit was to be derived except the reduction in the amount of steel required, this alone would be a sufficient incentive to develop methods of designing trusses which would not only obtain economy in material, but which would show economy in construction.

It has been definitely shown, at least to our satisfaction that the cost of welding trusses is no more than the cost of riveting trusses, and if such continues to be the case the over all cost of welded trusses will continue to be less than the over all cost of riveted trusses. Trusses are fabricated in the shop where actual and definite costs can be more readily established than in the field and the work can be under closer supervision, but there has been insufficient experience to date to determine the actual cost of field work with respect to riveting versus welding. Experience also has not been sufficient to determine the best form of field connections where welding is to be used, while on the other hand the long experience we have had in bolting and riveting structures has determined very exactly the best forms of bolted or riveted

*From a paper read before the Affiliated Technical Societies of Boston, in Tremont Temple, Boston, Mass., December 14, 1927.

†General Electric Co., Schenectady, N. Y.

connections to use. It will, therefore, be necessary for all of us to have considerable patience while this problem is being worked out.

The speaker will not claim that welding is ready to displace riveting on field work, but he does claim that development to date indicates that when the technique of field work on welding has reached the high standard which has been reached by riveting, that the cost will not only be comparable, but may even be less, with the additional satisfaction that the quiet of the neighborhood will not be disturbed by the terrific racket of the riveting hammer. Let us also say, however, that we will not, at least for some time, entirely displace pin type connections for erecting purposes. There are at the

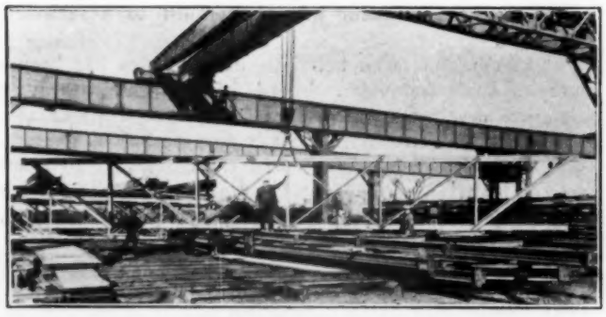


Fig. 4. Setting up Truss Prior to Tests.

present time no types of field connections in sight which offer any easier method of bringing members into proper position than field bolting. It may be that some type of joint not yet foreseen will solve the problem, but for the present we prefer to continue the use of field bolts for the temporary connections required when steel is erected.

When an engineer desires to accomplish a definite purpose he naturally analyses his problem into its simplest terms and then determines the fundamental principles involved. In the design of trusses the methods of calculating stresses have long been determined and there is, therefore, nothing to say

Fig. 5. View of Test Trusses. Partly Loaded.

at this time on the subject. If then the stresses can be readily calculated, there is only one problem left and that is to determine the actual unit stresses to be used for the various types of welds. In order to obtain data for these units the literature on the subject was carefully examined and it was found almost invariably that the specimen itself either distorted badly or broke before the welded joint had reached its maximum capacity. Obviously, that type of test specimen was wrong. It then became necessary to design a test specimen which would fully develop the welded joint to its ultimate capacity without the specimen itself being stressed beyond its elastic limit. In other words, the welded joint must be broken before the specimen became distorted. In this way the unit stress would be determined for the welded joint and would not be affected by an entirely different problem, that is the unit stress in the member. We are all accustomed to testing steel members independently of riveted joints, but for some unknown reason when welded joints were tested the specimens were not designed to actually test the joint, but more to prove that sufficient welding could be applied to completely distort or cause the member to fail. Of course this latter type of test was of no value in furnishing data for the design of welded joints. It was merely spectacular without producing unit stresses.

From the information given above you will note that specimens for welding tests must be most carefully designed, and a group of twenty-four specimens were so designed for welds of 3, 4, 5 and 6-inch lengths. These specimens were in groups of three, each group designed for testing in tension and compression. In all cases, however, the welds were designed to fail in shear on a plane perpendicular to the long side of the triangular cross section of the weld, as indicated in Fig. 1. This section of the weld, being its weakest plane, is in pure shear if no secondary stresses occur at the joint due to deflection or distortion of the specimens. Of the 96 welds in this series of tests 93 broke along the shear plane and three broke along the contact plane, the shear plane being defined as the plane across the triangular cross section of the weld as mentioned before; and the contact plane being defined as

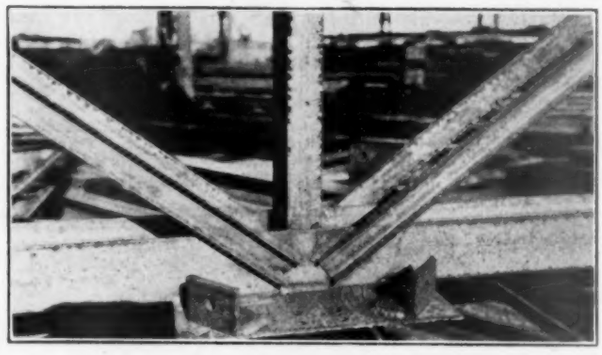


Fig. 6. Close-up of Bottom of Truss at Center, Where One Compression and Two Tension Members Join Bottom Chord Members.

the plane where the welding material is in contact with either member to be joined together. In each of the three cases where the specimens failed at the contact plane, bits of the parent metal were torn out showing that thorough fusion had taken place, and in these three cases the unit stresses developed were directly comparable or equal to those where failure was in shear. In order to indicate the uniformity of these tests a diagram is given in Fig. 2 on which is plotted each test. These groups are divided into two parts, the compression group and the tension group. You will note that the compression group gave higher values than the tension group, and this has been explained by the fact that the compression group were short chunky specimens in which bending could not occur due to the stresses in the specimens while the tension group were of necessity long specimens in which bending would occur even though the stresses were within the elastic limit.

From the tests so made it was determined that welding with a minimum contact distance of $\frac{5}{16}$ inch and a maximum contact distance of $\frac{3}{8}$ inch, the variation being specified to allow for the inaccuracies of workmanship, permitted a unit stress of 3,000 lbs. per lineal inch. The test indicated a range of 11,570 lbs. to 14,040 lbs. per lineal inch, with an average of 13,055 lbs. per lineal inch for welding of $\frac{5}{16}$ inch contact distance, with ten of the twelve specimens having a value of 12,300 lbs. or more per lineal inch and the other two 11,570 lbs. and 11,930 lbs. per lineal inch. You will observe that basing the unit stress on the values obtained from the tension specimens alone, a factor of safety of four or better is obtained in practically all cases. If on the other hand the compression specimens are considered, a factor of safety of five or better is apparent in all cases. It is, however, necessary to be conservative in any new type of design, and it was for this purpose of being conservative, together with the thought that we must not handicap a new method by too low unit stresses, that the value of 3,000 lbs. per lineal inch was adopted.

You have then before you the two essentials of truss design, first the fact that the stresses can be readily calculated for the various members and joints; and second the unit stress to be used for the design of the joints. The unit stresses used for the design of the members of the trusses mentioned as examples were, of course, those regularly used in the design of structural steel in accordance with standard American practice.

We will now turn to the development of the design of the truss itself. It was, of course, necessary to make various designs and compare them with riveted trusses in order to see what results would be obtained. Gusset plates are entirely

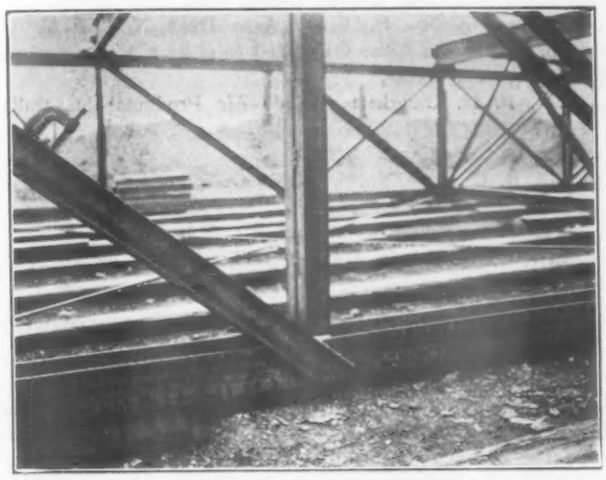


Fig. 7. Close-up of Junction of One Tension, One Compression and Bottom Cord Member, Showing Welded Joints.

eliminated in the welded design, and this is another element of welded design which results in economy. On the riveted truss the stresses in the members must be cared for at the joints by riveting through gusset plates. In other words, the members are not directly connected together, but are connected to another element, the gusset plate, which means that the connections are made more than once for each joint in nearly all trusses. In the design of the welded truss, however, the members are directly connected to each other so that a unit of connecting material in the welded design is performing one unit of work while more than one unit of connecting material is required in the riveted design in order to perform one unit of work. The comparative sections also indicate that simpler members can be used, resulting in a saving of rolling cost, handling cost, paint, and inspection.

A Carnegie beam is more economical for top and bottom chords than channels and angles for top chord and angles for bottom chord as in the case of the riveted truss. Furthermore, a study of the design of Pratt trusses indicated that angles and I-beams could be used for the compression members and channels for the tension members, and that all these members could be welded together without the use of gusset plates. The welding is symmetrical with the center line of the truss members; and the amount of welding can be directly and easily calculated from the stresses in the members. The problem is just exactly as simple as in riveted construction. The saving in weight by using welded trusses, given at the beginning of this talk, refers to these designs, but your attention is again called to the comparative simplicity of the welded truss with respect to the riveted truss, the omission of gusset plates, and the fact that one unit of material in a welded truss performs one unit of work while more than one unit of connecting material is frequently required to perform one unit of work in riveted construction.

For the present it is desirable that welded connections should be designed as simply as possible, that the areas of welding should be concentric with the center of gravity of the members and that all welds should be designed as shear welds. At the present time tests are being developed for other forms of welding connections, but until these tests are repeated enough times to determine definitely the unit values of such connections we have decided it is desirable to continue the simple connections now being used. Riveting and welding should be compared with respect to their relative economy

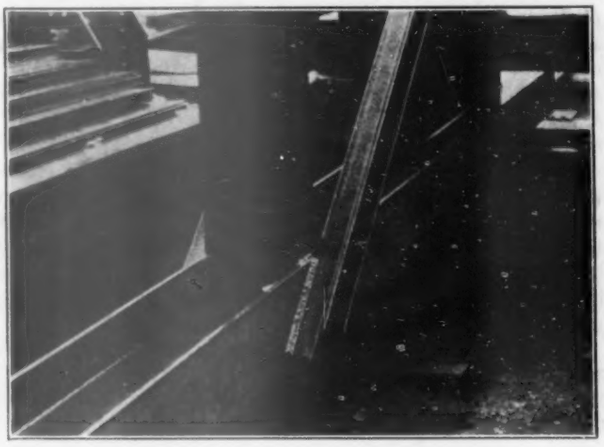


Fig. 8. Semi-Side View of Joint Shown in Fig. 7.

in each particular work and whichever proves the more economical should be used. There is no conflict of merit between the two methods, simply the age old conflict of

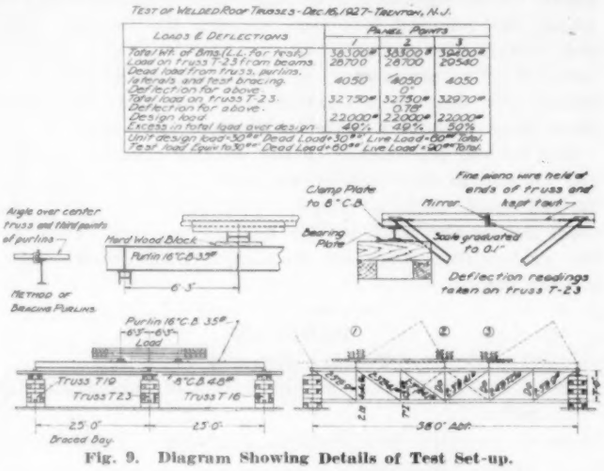


Fig. 9. Diagram Showing Details of Test Set-up.

economy, and whichever proves to be the more economical will survice in its proper sphere. But certainly our experience with welded trusses indicates that this is a field where arc welding is rapidly proving its utility.

APPENDIX

(*Note: Some of the tests referred to by Mr. Vogel were described and illustrated in the December, 1927, issue of The Welding Engineer. It is believed that this is a proper place to introduce the official report of load testing of the trusses described. The illustrations, with the exception of Fig. 1 and Fig. 2, accompanied the report of the tests at Trenton, N. J.—Editor.*)

WELDED ROOF TRUSS TESTED

That electric arc welded roof trusses will safely withstand the stresses for which they are designed, was demonstrated by tests conducted at the American Bridge Company's plant in Trenton, N. J., on Friday, December 16. At that time a live load double that for which the truss was designed was placed on the truss with satisfactory results.

The general plan for a welded roof truss, as announced last December, was prepared by William Dalton of the Gen-

eral Electric Company, from which a number of trusses of varying lengths and loads were designed and built by the American Bridge Company for the tests. It is claimed that a welded truss can be built with less metal and at less expense than the riveted type for the same load and span.

In testing the trusses at Trenton for their ability to withstand the load for which they were designed, three trusses of 58-foot span each were used. These were set up in the plant yard, parallel to each other the same as in a building and in such a way that, when loaded, the center truss would carry the load. Deflection readings were taken by means of a fine piano wire held at the ends of the truss and kept taut, a scale graduated in tenths of an inch being used with a mirror to show the deflection under load.

The first readings were taken when a point was reached where the load was equivalent to the normal load for which the truss was designed, and these readings showed a deflection of .52 inches. When the truss was carrying double live load the reading was .78 inches. At no time was there any indication of weakness in the structure and the engineers present expressed satisfaction with the results obtained.

The normal live load for which the truss was designed was 30 pounds per square foot of total roof surface. As tested, a load was applied equivalent to full dead load plus 60 pounds live load per square foot of total roof surface.

SOUTH-WEST HOLDS SECOND ANNUAL WELDING CONFERENCE

The second annual welding conference was held at the North Texas Agricultural College on February 7th and 8th. About two hundred fifty men attended the two-day session and everyone expressed their pleasure over the successful outcome. The manufacturers, jobbers and welders were very enthusiastic over future conferences and plans are already under way to hold a better conference next year.

Due to the prominence of the welding industry in Texas and Oklahoma there can be no doubt as to the value to be derived from such meetings. The discussion which took place during the meeting just held shows very clearly that the welders themselves are thinking seriously about improving the game.

PROGRAM

Tuesday, February 7

10:00 a. m.—Registration and inspection of buildings and exhibits.

11:30 a. m.—Mr. Roy Burdett, presiding. Engineering & Trades Department.
Welcome Address: E. E. Davis, Dean of N. T. A. C.
Address: "Outlook for the Welding Industry in Texas for the Present Year":
Mr. Ladue, Southwest Welding Supply Co., Dallas.
Mr. Hoard, Wichita Falls Oxygen Co., Wichita Falls, Texas.

1:00 p. m.—Lunch at College Dining Hall.
Address by Mr. N. S. Hunsdon, State Supervisor of Industrial Education, Austin, Texas.

2:30 p. m.—Paper: "Economical Use of the Cutting Torch,"
Mr. A. J. Fausek, Modern Engineering Co., St. Louis, Mo.
Paper: "General Aspects of the Oxy-Acetylene Process,"
Mr. G. O. Carter, Consulting Engineer, Union Carbide Company, New York.
Paper: "Application of Arc-Welding to Structual Steel,"
Mr. A. G. Bissell, Welding Engineer, Westinghouse Electric Co., Pitts, Pa.

7:00 p. m.—Informal Dinner at College Dining Hall.
Toastmaster, E. E. Davis, Dean.
Motion picture and paper: "Study of the Flow of Welded Metal," Mr. J. B. Green, President, Fusion Welding Corporation, Chicago, Ill.
Motion pictures and paper: "Atomic Hydrogen Welding Flame," Mr. Van Kirk, General Electric Co., Dallas, Texas.

February 8

9:30 a. m.—Motion pictures, "Oxygen, the Wonder Worker."
By Air Reductions Sales Co., New York.
Paper: "Application of Arc-Welding to Pipe Line."
Mr. Ackerman, Air Reduction Co., New York.
Paper: "Training Men for Welding Industry,"
Mr. Si Rickel, Big Three Welding Co., Fort Worth, Texas.
Paper: "Manufacture and Uses of Carbide,"
Mr. M. C. Stone, Engineering &Trades Dept., N. T. A. C.

1:00 p. m.—Lunch at College Dining Hall.
Address by Geo. L. Dickey, Asso. Dean, N. T. A. C.

2:30 p. m.—Paper: "The Oxwelded Joint as a Mechanical and Structual Detail,"
Mr. B. H. Daugherty, Linde Air Products Co., Dallas, Texas.
Paper: "Welding with Bronze,"
Mr. B. C. Price, Smith Welding Equipment Corporation, Minneapolis, Minn.
Paper: "Stelliting Metal Parts,"
Mr. C. W. Metzer, Haynes Stellite Co., Houston, Texas.

WESTINGHOUSE REVIEWS YEAR'S ACHIEVEMENTS

Westinghouse Electric & Manufacturing Company has issued a 45-page review entitled "Engineering Achievements of the Westinghouse Electric and Manufacturing Company for the year 1927," which outlines the development of new products and refinement of designs and construction of the old lines of products, in such a wide variety of fields as stokers, turbines, generators, transformers, electric marine power plants, and airplane propellers. Under the heading of Electric Welding the review has this to say:

"This construction continues to displace both riveting and casting, and threatens to occupy a large part of both fields eventually.

"The first all-electric-welded railway bridges have been built this year. One (Boston & Maine) is at Chicopee Falls, Mass. Electric-welded throughout, it was designed to that end, being made of plates without angles. A somewhat similar bridge on the Westinghouse Interworks Railway was built about the same time. During the year, riveted bridges on several railroads have been reinforced by welding.

"The heaviest responsibility yet put on welded structures is a factory building 70 feet by 220 feet, 80 feet high, with floors designed for loads of 300 lb. per sq. foot. Rivetted, it woudl have weighed 885 tons—instead of 790, as it stands.

"It is announced that our Navy's new 10,000 ton light cruisers will use electric welding to a considerable extent in their construction.

"New electrical machinery built by the Westinghouse Electric and Manufacturing Company is being fabricated by welding, a typical case being a synchronous motor without any castings, save the bearing pedestal, collector rings and brushholders, and without machine work on the stator. Bedplates of all sizes are being so fabricated.

"An industry, growing so rapidly, deserves something better than stationary machines mounted on trucks. A new built-in steel-enclosed welder was designed from the start to be portable. The frame is part of the truck, the control panel is built-in and steel-enclosed—it is lighter, smaller, more rugged, and has a trifle better electrical performance than previous portable welding sets."

Briggs Weaver Machinery Co., of Dallas, Texas, have recently taken on the distribution for their territory of the gas welding equipment manufactured by the National Welding Equipment Co., of San Francisco.

G. P. A. Meet in Winter Convention

Gas and Equipment Manufacturers Review Year's Technical Advance and Plan for Further Expansion of Oxy-Acetylene Industry

THE 14th mid-winter meeting of the Gas Products Association, held at the Palmer House, Chicago, January 26, 27 and 28th was declared a successful convention by the hundred members and guests who attended. From the standpoint of the breadth of topics included in the program, and the importance of information brought out in the papers and discussions, the meeting proved to be well worth while.

The significance of President C. O. Epperson's remarks in his opening address, expressing great confidence in the future of the oxygen and acetylene manufacturing industry, became more manifest as the meeting progressed. Mr. Epperson pointed to the challenging fact that there still remain practically untouched markets for the welding and cutting gases, and that these markets are ripe for development because of the definite economies which the oxy-acetylene process can bring to them. That such development would require the active, organized cooperation of gas and equipment manufacturers was the keynote of Mr. Epperson's address. Citing the accomplishments of other industrial associations, he showed how important a group of this sort can be as an educational factor in all of the metal-using industries, and he then proceeded to recommend practical means by which this function of the Association could be accomplished.

One group of papers, dealing with various phases of the manufacture of acetylene, was an important one to this convention because of the fact that during the past few years a number of members of the Association have added the production of acetylene as a logical corollary to the production of oxygen, and since the generation of this gas involves distinct problems there was felt a need for a treatment of such problems by those qualified by long experience.

The first paper in this group, "Generating Acetylene on a Large Scale," was read by R. A. Witherspoon, of Shawinigan Chemicals, Ltd., Shawinigan Falls, Canada, said to have the largest acetylene generating plant in the world. Mr. Witherspoon gave many interesting and valuable details of operation and maintenance, such as the effect of dropping chunks of carbide from a height into a steel hopper, and the results of allowing a conveyor to wear to the point where certain parts were out of alignment, causing a spark and a consequent explosion. After pointing out the necessity for close inspection and supervision of equipment and operations, Mr. Witherspoon explained in detail how his plant had solved these problems so successfully that serious explosions are now practically unknown. The precautions followed are simple and chiefly the result of application of common sense in the handling of carbide.

Practical details of acetylene plant operation were given by R. H. Sullivan, of Acme Oxy-Acetylene Co., Chicago, and by C. V. Moody, Purox Company, Los Angeles, whose papers dealt chiefly with problems of generation and compression, and of the physical requirements of a plant designed for the manufacture of compressed acetylene, Mr. Moody giving a number of valuable suggestions for the construction and operation of such a plant. The reading of these papers was followed by a discussion of the subject by producers of acetylene who covered in thorough manner many of the fine points involved in the manufacture of this and other compressed gases, as well as problems of distribution of these products.

Under the general subject of production of oxygen can be grouped several other papers of special interest to the gas manufacturer, since oxygen is the principal gas product of the active members of the Association. One paper of particular value to this group on account of the quantity of caustic potash used for drying of oxygen was read by C. W. Brown, of Innis, Speiden Co., Chicago, on the determination of the quality of caustic potash prior to its use. A discussion followed, led by J. T. Butler of Burdett Oxygen and Hydrogen Company, on the practical limits of drying oxygen before compressing, and of the relative merits of various methods, chemical and mechanical, for drying oxygen. On the latter subject a paper read by Mr. E. C. Holden presented some interesting facts regarding the use of Silica-Gel for this purpose. A paper prepared by E. J. Luening of Kentucky-Oxygen Hydrogen Company described a method of checking the measurement of gas by using a standard cylinder attached to a weighing platform as a master cylinder to make sure that the amount of gas put into all of the cylinders on the charging manifold should be correctly determined.

One subject of interest to producers of all of the gases, "Production of Gases from a Fire and Explosion Insurance Standpoint," was covered thoroughly by H. E. Dougan, Engineer with Archer and Meek, Columbus, Ohio. Mr. Dougan answered a number of questions raised by members regarding the proper insurance protection against risks in the production and distribution of gases, as for example the "borderline" case where the damage might be laid to either fire or explosion, showing the necessity for proper coverage on both causes in the insurance policy.

There was considerable evidence in the program of the growing importance of pipe welding as an outlet for the welding and cutting gases, not only in the case of long pipe lines for transmission of oil and natural gas, but also in pipe installations in industrial plants for steam, water, gas, air and vacuum lines and in heating systems for buildings of all sizes. The advantages of welding as a means of joining pipe have been brought to the attention of hundreds of heating and plumbing contractors during the last year or two, and the growing interest shown in the subject of pipe-welding among piping contractors and plant engineers is evidence that this missionary work is beginning to reap results. One contractor who has adopted the use of welding wherever the owners of a building can be persuaded of the advantages to be gained, is G. W. Macauley, of Grand Rapids, Michigan, who told of his experiences in endeavoring to overcome the screwed-fitting tradition. He also told of the welding procedure followed in a number of installations, and the results obtained in the matter of costs and efficiency. A number of stereopticon slides illustrated the points proved by the work of this contractor, which is typical of the case presented by a number of others who have adopted welding as standard procedure.

Mr. Macauley's paper was followed by a lively discussion of the subject, which brought home the fact that the work of educating the piping trades and the engineering profession to the use of welding has hardly begun, the chief obstacle being, it seems, a natural inertia to adopt methods so radically different from those followed for generations. A

step in the right direction is the effort on the part of some contractors and some manufacturers of welding equipment, to provide instruction in pipe welding, in some cases through the cooperation of welding schools, for plumbers and steamfitters. It has been found, as was pointed out in the discussion, that better results are obtained by making welders out of steamfitters than by trying to train experienced welders in steamfitting.

Another phase of this subject was covered by J. G. Hart, General Manager, North Shore Gas Company, Waukegan, Ill., who have been using welding on an increasing scale in the laying of their gas lines. Mr. Hart explains the complete success of the welding done by his company by the fact that, having selected experienced welders, they proceed to follow the methods which assure the soundest welds, speed and cost being secondary considerations. The experience of the company, as the result of this policy, has been that they have invariably produced completely successful welded lines, requiring no further attention after laying, and that the cost in labor and material has been very little more than would have been required had the job been rushed through without proper regard for the best welding procedure. It is the belief of this company that such a policy makes for economy in the long run.

There were a number of technical papers on the program which covered other subjects of interest and importance to the industry. W. M. B. Brady, of General Electric Company, described the new atomic hydrogen process, which offers a new market for hydrogen. Mr. Brady made it clear that the new process is not expected by its developers to supplant, but rather to supplement, the present electric and oxy-acetylene processes in special applications where welds of great ductility or certain other properties are required.

A paper by C. A. Crawford on the Welding and Brazing of Monel Metal and Nickel gave complete details of procedure for welding these metals, with the precautions to be observed in order to get satisfactory results, and with illustrations showing a number of different kinds of equipment made of Monel metal which probably could not be satisfactorily welded in any other way.

The problem of the great replacement costs of worn railroad track has been solved by the building up of the rail-ends, where the wear normally occurs to the greatest extent. The procedure which is becoming quite generally adopted is to use oxy-acetylene welding to replace material in cupped rail-ends, enormous savings having already been made in this manner by some roads. E. G. Luening submited a paper describing a long series of tests of built up rail ends, using different kinds of welding rod. In making such tests, it is necessary to make a large number of welds with each rod, or each change in procedure to be tested, over a stretch of track where an exact record of the volume and nature of traffic has been kept. These traffic figures (such as, whether freight or passenger, number, length, and speed of trains, etc.) must be taken into account when making a fair comparision between results on the various lengths of track.

Another railroad operation which is attracting considerable attention on account of the excellent results obtained is the repair of locomotive frames by bronze welding. G. M. Calmback, General Welding Supervisor of the Wabash Railroad at Decatur, Ill., related his experience with bronze welding in locomotive repair work and gave details as to the service received from locomotives repaired in this manner. The fact that repairs can be made more cheaply, usually without dismantling, and that they often can be made when necessary wherever the locomotive happens to be along the line when the break occurs, reducing to a minimum the loss of service of the engine, have been large factors in the growing acceptance of this method.

"High Quality Welding" was the subject of the paper by Dr. A. Krebs, General Welding and Equipment Co., Boston. Dr. Krebs recently returned from an extensive trip through Europe, where he studied the oxy-acetylene welding technique employed in the various countries, particularly in the fabrication of pressure vessels. He paid special tribute to the fine welding craftsmanship of the Swiss operators, which has resulted in the general adoption of welding in the fabrication of pressure vessels for all purposes in Switzerland. He described the method they used of welding vertically and told of the excellent results obtained by following this practice.

The last technical subject included in the program was the oxy-acetylene cutting of steel plate and other rolled steel shapes, with particular emphasis on the use of mechanical methods for controlling the direction and speed of travel of the torch. This subject is rapidly becoming of considerable importance with the increasing tendency toward the substitution of rolled steel for iron castings, which is causing many revolutionary changes in the design of heavy machinery, at the same time making necessary the use of the cutting torch as the only economical means of cutting these plates, beams, etc., to dimension.

A number of examples were illustrated by J. J. Kutscheid showing the smooth, accurate cuts obtained, with great savings in time, by the use of a machine designed to control the movement of the torch over the desired pattern.

The technical sessions were well attended, and most of the papers were followed by discussions of the subject treated. These discussions brought out much information of value to the industry. The central thought which correlated the topics covered in all the papers was the expansion of the oxy-acetylene industry. The variety of fields represented in the program provided an impressive picture of the markets, existing and potential, for the welding gases and equipment.

About one hundred members attended a thoroughly enjoyable theatre party on Friday evening, and the convention closed with a banquet at the Palmer House.

WELDING CONFERENCE OF UNIVERSITY OF WISCONSIN WELL ATTENDED

The interest shown in welding conferences which have been held at a number of universities within the last two or three years led the University of Wisconsin to arrange a similar program for the benefit of operators, engineers, and manufacturers in that territory. During the three-day session at Madison on February 8, 9, and 10, twenty-two papers were read on a wide variety of subjects pertaining to all of the welding processes. The conference was divided into separate sessions for structural engineers, chiefs and operators, and foundries. One session was devoted to demonstrations of welding of thin gauge material, thermit welding, electric arc and atomic hydrogen welding, and, in addition, tests of the demonstration welds were made by the Mechanics Department.

Besides the papers read by representatives of manufacturers of welding equipment, there were several addresses by members of the engineering faculty of the University, on "What the Engineer Demands from the Structural Joint," "Side Lights on the Development of Welding," and other subjects. At the supper on the first evening, Governor Fred R. Zimmerman addressed the conference on "Co-operation of Industry with State and University," and on the following evening Dr. Glenn Frank, President of the University, spoke in his usual inspirational manner.

The conference closed with demonstrations by practical welding operators and an auto clinic at Randall Shops Laboratory.

Red-Shortness of Weld Metal*

British Welding Engineers Investigate the Causes of Brittleness of Some Welds at Red Heat, and Means of Controlling Crystalline Structure

By A. H. Goodger

THE term "red-shortness" is used to describe the property certain normally ductile metals show of being brittle at a red heat. That is to say, at a red heat the metal is no longer ductile and refuses to roll or bend without cracking or breaking up. This trouble is usually due to the presence of certain impurities such as sulphur or oxygen, which may give rise to brittle films between the grains. The fractures are usually intergranular.

It is now clearly recognised that many fusion welds are red-short, and particularly is this the case with electric arc welds. The author's attention was the first drawn to this fact by Mr. Daniel Adamson. Mr. Adamson, in 1919, carried out a number of tests to find out whether it was possible to make forgeable welds. Semi-circular plates were welded together to form a circular plate about 12 inches diameter; this plate was then heated to a temperature of 850°C. to 900°C., and pressed through a die to a cup form. This is really a form of the Ericssen test for sheet metal.

The welds, in order of merit, were made as follows:—

1. Acetylene welded by J. Adamson & Co.
2. Electric welded by the author with 0.3 per cent carbon steel electrodes, flux covered.
3. Electric welded by J. Adamson & Co., with similar electrodes.
4. Electric welded with low carbon steel electrodes.
5. Carbon arc welded.

Curiously the tests were repeated on basic steel and showed decidedly inferior results. The tests were verified by the author and it was found that the electrodes with the lowest carbon content always gave the worst results; the weld metal appeared very decidedly red-short. The original weld was quite sound, but the forged weld was cracked in all directions, the fracture being decidedly intergranular. The aceteylene weld test stood up quite satisfactorily, and it was found that unless the conditions were definitely abnormal, such as those set up by a definitely oxidising flame, the acetylene weld was always forgeable.

Although most electric welds appear thus to be red-short. Eschholz gave particulars in the "Electric World"—1922—of weld tests which had been forged with very good results. The details of analyses were:—

	C.	Mn.	S.	P.
Electrode	0.16	0.56	0.024	0.032
Weld	0.05	0.19	0.013	0.024

The effect of forging on a low grade weld was marked:—

	Tensile. lbs.	E. Limit.	Yield.	Elong.	Red.
Before forging	33,625	19,500	22,250	3.4%	10.0%
After forging	56,800	28,250	346,630	27.3%	27.3%

Eschholz also showed the effect of finishing temperatures on forged welds:—

Temperature.	Tensile.	E. Limit.	Elong.	Red.
1,150C.	58,790	23,000	33.9%	6.10%
900C.	57,200	29,500	34.9%	61.3 %
750C.	62,175	44,500	31.3%	50.0 %
As Welded	54,110	27,810	12.2%	17.9 %

The figures are very remarkable, but Eschholz also showed that many welds went to pieces in forging. No details were given as to how much the pieces were forged, or how it was carried out.

Miller ("Iron Age," 1921), showed that low carbon electric welds were unforgeable, stating that a weld made with a 3½ per cent nickel steel rod was forgeable. Other workers have shown that nickel steel welds are lacking in ductility.

It is well-known that considerable oxidation of the carbon and other elements in the electrode takes place in the arc. Dr. Paterson cited an instance of a steel wire containing 7 per cent carbon giving a weld of the following composition:—

Carbon	0.152 per cent.
Oxygen	0.161 per cent.
Nitrogen	0.095 per cent.

He stated that carbon was not fast enough as a deoxidiser. In the "Journal of the Society of Chemical Industry"—September, 1919—he gave further examples:

	1	2	3
Carbon in Wire	0.112	0.059	0.57
Carbon in Weld	0.04	nil.	0.15

Similar examples are given by the Bureau of Standards.

Ramage, Watts and Owens ("Welding Engineer"—1921) stated that welds lose their ductility when quenched at about 900°C., and found a critical range about this temperature, at which welds containing needles in the structure went to pieces on forging. They suggested it was due to nitrogen.

It would be imagined, having regard to the analysis of the weld metal, that oxygen was the cause of this red-shortness. Ruder was, however, of the opinion that although all electric welds have a high oxygen content due to the oxidising conditions under which they are made, that oxygen alone could not account for the lack of ductility. The opinion is now very largely held that the lack of ductility is due to the presence of nitrogen.

In a paper on "Welds" by Messrs. Law, Merrit & Digby ("Iron and Steel Institute"—1911), large numbers of needles are shown in a carbon-arc weld, which the authors describe as magnetic oxide, stating that they render the welds liable to corrosion. Primrose in "Metallography of Steel," also shows these needles as magnetic oxide of iron. These needles are present in practically all arc welds, but the view held by most workers nowadays is that they are nitride of iron. This is based on the similarity in appearance to those seen in steel, which has been heated in ammonia gas at about 600°C.; first described by Dr. Percy. These needles have been shown to be iron nitride, Fe_4N, separated out along the cleavages. It is an established fact that iron will take up about 7 per cent nitrogen when heated in ammonia.

Strauss ("Stahl und Eisen"—1914) gave figures showing the increase of tensile strength and drop in ductility of steel with increasing nitrogen content:—

0.07 Per Cent. Carbon Steel Bars Treated at 700°C. in Ammonia Gas

	N.	Tensile.	Elongation.
Untreated	0.004	49,360	31.5
Ammonia, 24 hours	0.1	59,170	24.2
Ammonia, 48 hours	0.11	58,460	21.8
Ammonia, 72 hours	0.16	60,880	22.5
Ammonia, 96 hours	0.22	63,860	21.8
Nitrogen, 48 hours	0.004	50,350	31.8

**Paper read before the Institution of Welding Engineers, London, June 22, 1927.*

There was no effect from nitrogen gas alone.

These figures give much higher ductilities than are usual in electric welds containing the same amount of nitrogen.

Wimmer ("Stahl und Eisen"—1925) described how he added varying amounts of iron oxide to molten steel low in carbon, and found the plasticity in the hot and cold state greatly deteriorated, while grain size increased. Similar work by W. Austin is described in "Iron and Steel Institute Journal"—1915—in which he found that alloys of iron and oxygen could be rolled and forged between 750°C. and 850°C., but difficulty was experienced about 900°C.

Pickard ("Carnegie Memoirs"—1919) has shown that iron oxide is soluble to 0.405 per cent in liquid steel.

Having the above facts in mind, an investigation was carried out in order to determine the cause of red shortness in welds and to find out what effect carbon had in this connection on the weld metal. It was also desired to perfect an electrode which should give a weld suitable for use in case hardening boxes, annealing pots, etc. Such articles welded with low carbon electrodes very rapidly fell to pieces; the end might fall out of a case hardening box on the first or second heat.

An examination of the behaviour of fluxes and their effect both on the weld metal and on the arc, was first undertaken.

An extraordinary number of fluxes have been devised, but very little scientific information has been published, as most of these fluxes are largely experimental in their nature. Table I shows representative compositions of fluxes in commercial use.

Table I.
Coatings Used on Electrodes

1. Blue Asbestos Yarn $(FeNa_2)_4Si_4O_{12}FeSiO_3$	Essentially ferrous silicate. SiO_2 52% FeO 40% MgO 2% Al_2O_3 1%
2. Blue Asbestos White Asbestos Sodium Silicate	
3. White Asbestos China Clay Sodium Silicate	Openly wound. MgCa Silicate. $Al_2O_32SIO_22H_2O$ Na_2SiO_3
4. White Asbestos Sodium Salts	Sodium Silicate, carbonate, chloride, borate, etc. Occasionally Calcium Fluoride.
5. Ferric Oxide Silica Sodium Silicate	74.5% 13.9% 9.58%
6. $CaCO_3$ Fe_2O_3 SiO_2	To give $CaO.FeO.SiO_2+Na_2SiO_3$ Occasionally carbon is added.
7. $CaCO_3$ Graphite Sodium Silicate	45.5% 17.9% 36.6%
8. $CaCO_3$ Fe_2O_3 SiO_2	10.78% 3.92% 77.6%
9. Slaked Lime.	

Aluminium, magnesium, nickel, lead, etc., are used as additions to several of the above flux coverings for the special purpose of deoxidising the molten metal.

Graphite, as a constituent of the flux, is of considerable value at times, but on soft steels is dangerous, tending to be absorbed by the steel on the work crater, or when a second layer is superposed on the first.

Many workers, including the author, have shown that nickel is a valuable constituent of the welding rod, tending to prevent oxidation. A flux of the nature of class 4 was adopted in the following experimental work.

Most workers have shown that there is little difference in the composition of the weld metal from a bare electrode and from a covered electrode, even with a high percentage of magnesium and aluminium in the coating. The magnesium appears to burn out before the need for it disappears.

The author found that the average carbon content of weld metal from 0.22 per cent carbon electrodes was 0.07. The best results obtained as regards retention of carbon were:—

	C.	Si.	P.	S.	Mn.
Wire	0.515	0.10	0.054	0.053	0.493
Weld	0.235	0.107	0.028	0.029	0.295

Wanamaker also gives the following figures:—

	C.	Mn.	P.	S.	Si.	Ni.
Wire	0.18	0.5	0.012	0.032	0.140	2.97
Weld	0.15	0.4	0.012	0.032	0.120	2.08

This apparently shows a considerable advantage for nickel as a constituent of the wire. He states, however, that a special flux was used, but does not give the composition.

Other Effects of Fluxes.—The slags formed readily dissolve Fe_2O_3 and, therefore, clean the surface of the work. The heating effect of the flux on the plate is very great, and ensures a molten pool ready to receive the electrode metal. A very considerable stabilising effect on the arc is noticeable, the effect of the magnetic field in the work being completely neutralised. With a bare wire the arc is equivalent to the hissing carbon-arc, and is inherently unstable. The flux appears to prevent the arc reaching the edge of the electrode, so producing stability.

The surface tension of the metal melted by the heat of the slag tends to draw it up into a globule, leaving the slag in its place, thus producing a nick at the edge of the weld. This defect can be eliminated to a large extent by careful manipulation of the electrode in use.

The appearance of electrodes coated with satisfactory and unsatisfactory fluxes is as follows:

Satisfactory.—Leaves a thin covering of slag over the end of the electrode.

Too infusible.—Forms a projecting cup.

Too fusible.—Flux melting off, and leaving the metal projecting.

The spreading effect of the flux is well shown by observing sections of welds made with covered electrodes and bare electrodes respectively. A disadvantage of fluxes lies in the fact that inclusions are liable to occur.

An electrode designed to prevent absorption of oxygen or nitrogen during welding should have a flux covering conforming to the above satisfactory properties. It should give a uniform covering to the molten metal at all stages. A flux containing an excessive amount of oxide of iron can scarcely be considered suitable for the prevention of oxidation.

The Passage of the Metal through the Arc.—Several workers have investigated the iron arc with a view to finding what happens to the metal as it passes from the electrode to the weld. Eschholz ("Electrical World"—1920) came to the conclusion from an observation of oscillograms, etc., that a globule formed on the electrode and enlarged until it bridged or short-circuited the arc stream and then became detached from the electrode end. This happened from 2 to 60 times per second. H. M. and F. M. Sayer also examined the arc spectroscopically and found that there was always a very strong vapour arc present and that any flux appeared to melt entirely outside the vapour arc.

The author examined the welding arc, photographically, by the aid of a Davidson Micro-Telescope, and a high speed shutter by which means details of the arc were clearly visible. At low speeds little detail was observable. A photograph of an arc with a bare electrode shows that a globule is forming at the end, larger than the electrode, and the number of sparks emitted indicates considerable burning. This arc is comparable to the hissing carbon arc, which is produced when the arc

reaches the edge of the crater. In a slow speed photograph of a flux covered arc, the only noticeable feature is that there is decidely less spluttering and burning. A high speed photograph at 5 diameters, of a fluxed arc shows the flux melting right outside the vapour arc. A darker patch at the end of the electrode was usually noticed and it was found to consist of boiling metal being ejected from the electrode end. A photograph taken in 1/300 second, of a fluxed arc shows the metal ejected as a boiling globule. There is, however, a strong vapour arc always present indicating that the globules at no time completely bridge the gap.

It will thus be seen that the conditions are such that a flux can only partially prevent the atmosphere from coming in contact with the electrode metal, and that the continual presence of the vapour arc is almost certain to lead to oxidised or nitrogenised metal. The flux appears to have more physical than chemical effects; it stabilises the arc possibly by preventing the arc reaching the edge of the crater. That the flux coating does have some protecting effect is shown by the fact that welds can be made with difficulty, under water and in pure oxygen with coated electrodes, an impossibility with bare wires.

Effect of Carbon Content of Electrode on Red-Shortness of Weld.—It was decided to examine the state of the weld metal both in the cold and in the hot state by means of bend tests, the hot bends being carried out at about 900°C., and the cold bends as welded without previous annealing.

A number of pieces of boiler plate were prepared with the edgs bevelled for welding, and it was decided to make welds with single Vee, double Vee and lap joints. The plates were welded with electrodes of carbon content varying from 0.1 to 1.2 per cent. The exact analyses are given below:—

No.	Carbon	Si.	P.	Mn.	S.
1.	0.08	0.022	0.021	0.22	0.02
2.	0.19	0.064	0.05	0.43	0.03
3.	0.43	0.097	0.058	0.65	0.037
4.	0.57	0.100	0.037	0.75	0.017
5.	0.65	0.104	0.032	1.12	0.04
6.	0.92	0.17	0.048	0.63	0.023
7.	1.20	0.23	0.033	0.40	0.021

Current Density.—The current used was 150-amps., for Nos. 1, 2, 3 and 4, and 140-amps. for Nos. 5, 6 and 7, at 60 volts. The high carbon electrodes required a slightly lower current owing to their lower melting point, and tendency of the carbon to cause slight spluttering. The electrode was made the positive pole.

The plates were given numbers after welding corresponding with the electrodes, and were then cut up.

Tensile Strength.—The figures obtained for tensile strength are given in Table II. The plates were left as welded, and the welds were, therefore, slightly full. A very high average tensile was obtained, but the elongation was erratic. It was definitely proved that better results were obtained with a double Vee than with a single Vee. The larger number of tests broke outside the weld, and no noticeable difference was found between No. 1 and No. 7.

Table II.

Single Vee. Butt Welds.

No.	Size of Bar	Fracture		Elongation on 10"	Breaking load per sq. inch Lbs.
1.	1⅜" × ½"	Weld	1⅞"	18.75%	55,900
2.	1⅜" × ⅝"	Weld (bad)	⅝"	6.25%	48,800
3.	1⅜" × ½"	Plate	⅞"	8.75%	57,600
4.	1⅜" × ½"	Plate	1⅞"	18.75%	61,500
5.	1⅜" × ½"	Plate	⅞"	8.75%	64,600
6.	1⅜" × ½"	Weld	¾"	7.5%	64,700
7.	1⅜" × ½"	Weld	⅝"	6.25%	61,900

Double Vee

1.	1⅜" × ⅝"	Plate	1½"	15.0%	62,800
2.	1⅜" × ⅝"	Weld	1"	10.0%	59,600
3.	1⅜" × ⅝"	Plate	1⅞"	18.75%	62,800
4.	1⅜" × ⅜"	Weld	⅝"	6.25%	57,800
5.	1⅜" × ⅜"	Plate	1⅞"	18.25%	74,700
6.	1⅜" × 9/16"	Plate	1⅝"	16.25%	61,900
7.	1⅜" × 9/16"	Weld	⅝"	6.25%	54,000

Lap Welds

1.	1⅜" × ½"	Plate	⅞"	8.75%	69,500
2.	1⅜" × ½"	Plate	½"	5.0%	63,500
3.	1⅜" × 9/16"	Plate	⅝"	6.25%	62,700
4.	1⅜" × ½"	Plate	11/16"	6.87%	67,000
5.	1⅜" × 9/16"	Plate	1⅜"	13.75%	61,400
6.	1⅜" × ½"	Plate	1¼"	12.5%	69,900

BEND TEST, SINGLE VEE. COLD ⅝ IN. PLATE.

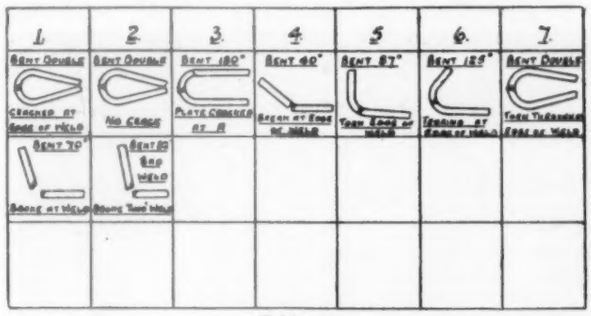


Table 3.

BEND TEST, SINGLE VEE. HOT ⅝ IN. PLATE.

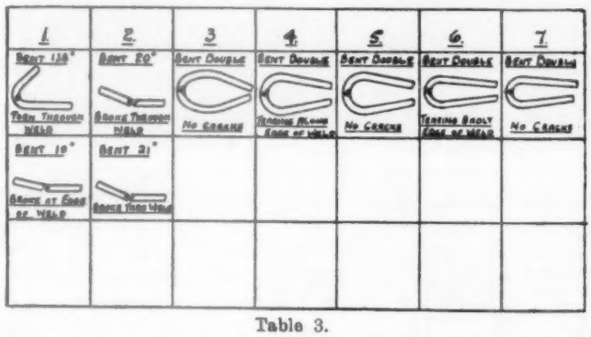


Table 3.

Bend Tests.—The bent tests were made in a special block, so as to give as nearly as possible a standard bend, the hot bends being carried out at 900°C. The bending of lapped joints is a rather crude test, but it involves a very severe load being exerted on the weld.

The results of the cold bend tests are shown graphically at the top of tables 3, 4, and 5, while the corresponding hot bends are given underneath. In each case two or more tests were made, and only the best bends obtained in each case are shown.

Cold Bends.—There is little difference between cold bends 1 to 7, but if anything, those made with the lower carbon electrodes are the best. Occasionally a bend with a defective weld broke in testing, in which case another test was made on the spare strip.

Hot Bends.—In the case of the hot bends a noticeable improvement is seen as the carbon in the electrode rises, the bends, 5, 6, and 7, being definitely free from red-shortness. The bending of the lap joints shows this to a very marked degree. This confirms the suspicion that the low carbon electrodes were responsible for the red-shortness in Adamson's tests.

Carbon Contents of Welds.—The welds 1 and 2 only contained a little carbon, that in No. 1 being the merest trace. There was a progressive rise until 0.354 per cent, was reached on Weld No. 7.

Electrode	0.08	0.19	0.43	0.57	0.63	0.92	1.20
Weld .....trace	0.04	0.128	0.13	0.235	0.22	0.354	

This shows that there has been a very considerable loss in carbon during welding, No. 7 having lost 0.846 per cent, although a short arc was used throughout.

Microstructure.—Microscopic examination showed some interesting facts. The specimens were taken from pieces cut from the spare bars, and were examined as welded, and also as annealed.

Weld No. 1 at 100 diameters.[1]—It is typical of low carbon weld metal; contains no noticeable pearlite, innumerable oxide inclusions, and the surface is full of the well-known needles.

The same specimen at 350 diameters.—Here the needles and oxide globules are easily seen.

Weld No. 1 at 1,250 diameters.—The characteristics of the needles are well shown. For the most part they are straight, and in most cases end at the grain boundaries.

BEND TEST, DOUBLE VEE. HOT $\frac{5}{8}$ IN. PLATE.

1	2	3	4	5	6	7
BENT 60° TORN AT EDGE	BENT 30° BROKE AT WELD	BENT 180° BADLY TORN	BENT 95° TORN AT EDGE	BENT DOUBLE NO CRACKS	BENT DOUBLE NO CRACKS	BENT DOUBLE NO CRACKS
BENT 22° BROKE AT WELD	BENT 10° BROKE AT WELD					

Table 4.

BEND TEST, DOUBLE VEE. COLD $\frac{5}{8}$ IN. PLATE.

1	2	3	4	5	6	7
BENT DOUBLE NO CRACK	BENT DOUBLE NO CRACK	BENT DOUBLE NO CRACK	BENT 80° BROKEN AT EDGE	BENT DOUBLE NO CRACK	BENT 143° BROKEN AT EDGE	BENT DOUBLE NO CRACK
BENT DOUBLE TORN THRU WELD	BENT DOUBLE NO CRACK	BENT 98° TORN EDGE WELD	BENT 84° BROKEN AT EDGE			
			BENT 39° BROKEN AT EDGE			

Table 4.

The structure of weld No. 2.—Dark patches of oxide, but there is an occasional patch of pearlite. As would be imagined, the carbon distribution in weld metal is very erratic, but the needles were fewer in number in this case.

Weld No. 3.—This was made with an electrode containing 0.43 per cent carbon, and the weld shows a definitely pearlite structure. There were now no needles present at all.

Weld No. 6 at 100 and 350 diameters. The junction of the weld and plate is shown. The metal still contains oxide inclusions, and minute holes, but it now shows a normal pearlite structure with no signs of any needles, either before or after annealing. The same is true of photographs of weld No. 7. The average carbon content of the weld, as determined by combustion, was 0.35 per cent and the electrodes 1.2 per cent.

It is obvious that the disappearance of red-shortness coincides with the disappearance of the needles and the appearance of the pearlite as a regular constituent of the structure. The nitrogen content of weld metal does not appear to vary whether the electrode has a high initial carbon content or not, but the oxygen figure comes down rapidly. This has also been demonstrated by Paterson and Blair. It has been shown by various workers that needles of nitride were formed when quite high carbon steels were heated in ammonia and that the needles remained quite independent of the pearlite, and yet in a weld the needles disappear as soon as the pearlite appears. Is it possible that the needles in welds are not nitride, or at all events, not always nitride?

The author calls attention to a photograph published by Ruder, "General Electric Review," of a weld made in nitrogen gas. Needles, if present, are decidedly few and far between. The structure of a weld made in carbon dioxide by the Bureau of Standards shows a very large number of needles. Unfortunately, they dismissed the fact with saying that evidently they were due to a different cause from those formed in iron fused in air.

Hohn, in a report of the Swiss Steam Users, 1923, stated that he has found needles in acetylene welds made with an excess of oxygen in the flame.

The author had noticed that several samples of Thermit metal showed needles in the grains similar to those found in welds and with a view to further information on the subject a sample of Thermit metal was made, out of contact with air, only CO_2 being allowed as an atmosphere. The grains contained many needles.

Welds Made in Oxygen Gas.—An attempt was now made to weld in oxygen gas. A special apparatus was constructed for this purpose and commercially pure oxygen 99.8 per cent was used as an atmosphere. With a bare wire welding was impossible but with a suitably covered electrode welding was quite feasible. Naturally a very considerable amount of combustion took place, probably ⅔ of the metal being burnt to oxide. The weld was very hot and an exceeding hot and thick layer of slag was formed. The structure of the resulting metal is a mass of fine needles. The inclusion appears to be an iron—iron oxide eutectic. The edge of the weld consists of a carburised zone formed by the plate, an oxidised zone formed by the weld and a neutral zone sandwiched in between. The needles continue right up to the edge of this neutral zone and then disappear.

In spite of the presence of needles in brittle welds they do not seem to affect the fracture, which avoids them and passes always between the grains just as though there were a brittle film there. Various workers have suggested that brittleness in some steels is due to presence of ultra-microscopic films of oxide between the grain, and Humfrey found that such brittleness was removed by heating in a reducing atmosphere.

A microphotograph was taken of a section of the Delhi column made of hand wrought iron by the Hindus 1,700 years ago; from a specimen kindly loaned by Sir Robert Hadfield. The unetched surface shows only occasional oxide inclusions. On etching it is seen that several of the grains contain the needle-like inclusions, and also that certain positions of the grain boundaries etch up much earlier than others, evidently due to an ultra-michoscopic film there. The nitrogen content of the metal is 0.032 per cent.

There is every reason for believing that the lack of ductility and the presence of red-shortness in welds is due to similar films, which are in all probability oxide. The presence of needles in a weld appears to indicate a state of red-shortness and an oxidised condition of the metal. The experimental

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[1] *Note: Although space limitations prevent reproduction of all the microphotographs, the author's comments on them indicate typical structures, and serve to show the basis of his conclusions. There were still a large number of oxide inclusions in the weld.*

evidence suggests that the needles themselves consist of extremely thin films of oxide separated from a solid solution on annealing along the cleavage planes of the iron grains. Their formation can be prevented and welds made which are definitely not red-short, by the use of electrodes incorporating suitable deoxidisers. Carbon, it is suggested, forms one such

BEND TEST, LAP JOINT. COLD $\frac{5}{8}$ IN. PLATE.

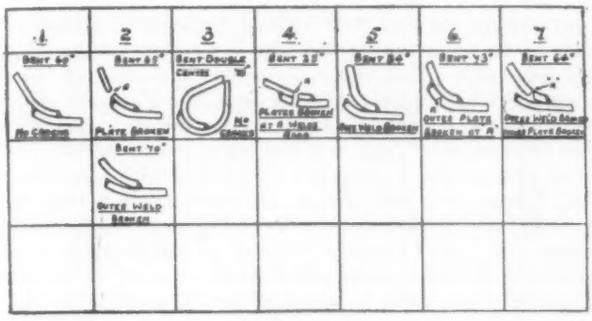


Table 5.

BEND TEST, LAP JOINT. HOT $\frac{5}{8}$ IN. PLATE.

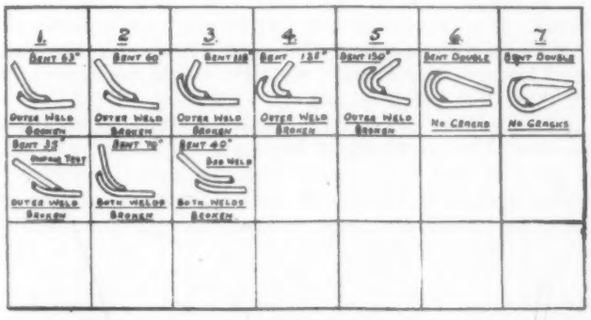


Table 5.

satisfactory deoxidiser as it is slow in its action and is not instantly burnt out as are some of the more rapid deoxidising agents. Very considerable success has attended the use of electrodes as described for work requiring to be used or manipulated at a high temperature.

The author would like to acknowledge the help of his assistant, Mr. R. C. Stockton, A.M.C.T.

(The discussion which followed the reading of this paper will appear in an early issue—Editor.)

HUGE GEAR REMODELED IN PLACE BY OXYGEN LANCE

On a Saturday morning in the sheet and tin plate mill of a steel plant a 23 ft. diameter split gear started to slip. A hasty inspection disclosed that the gear was already drawn up as far as possible. It would be necessary to remove metal from one section of the split hub in order to tighten the gear on the shaft. Since the gear was a part of the main drive, the mill of course would have to remain idle during the repair period.

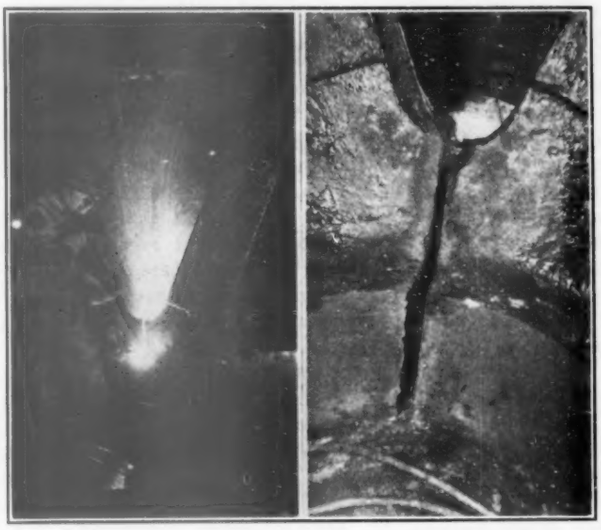
The master mechanic found that repairs would require taking the gear apart, transporting it to the machine shop and removing ¾ inch of metal from one section of the split hub with a planer. Dismantling, handling, machine shop work, and re-erection would have required four days and would have cost an estimated $2,000.

Since the mill was then operating on a 100 per cent production basis, stoppage of work on Monday, Tuesday and Wednesday would have meant a further loss to the plant of about $15,000 in profits on the material normally produced on those three days. The grand total of losses, however, would have been much greater than this because of delayed production schedules, general all-around disorganization in the normal routine of other parts of the plant, and charging off the normal plant overhead for the three unproductive days; to say nothing of the losses that would be occasioned by the three-day lay-off to the workmen.

All things considered, the mishap had begun to assume serious proportions when the superintendent suggested that it might be possible to make the cut by the oxy-acetylene process.

A service engineer of the company supplying oxygen to the steel mill was quickly called for a consultation. After investigation he reported that the excess metal could be removed by means of the cutting blowpipe supported by an oxygen lance. Accordingly the necessary equipment was assembled and the work started about Saturday noon.

It required 14 hours labor for five men to do this job of cutting. The total cost of the work, including oxygen, acetylene, labor and steel pipe for the oxygen lance, amounted to about $110.



Metal Cut from Split Bearing Without Removing from Shaft.

Fig. 1 gives some idea of the size of this gear. The section cut was 3 ft. 11 in. in greatest length and 15½ in. was cut from this surface, the cutting blowpipe therefore having removed altogether about 470 cu. in. of cast steel from the hub. Fig. 2 shows the finished cut.

The cost of oxy-acetylene cutting was just a little over one-twentieth of the estimated cost of machining, and handling to the machine shop and back. The important factor, however, was the saving in time. The job was completed by Sunday afternoon and the gear was tightened in place and ready for operation when the whistle blew on Monday morning.

Thus, what at first appeared to be a serious and costly emergency was reduced to only four hours of lost working time and a small charge for materials and labor by judicious use of the oxy-acetylene process.

OBITUARY

CHARLES LEON SNOW died January 6 of heart disease at his home in New York. Mr. Snow was born at Portland, Me., June 7, 1875, the son of Charles E. and Olivia Stuart Snow. He prepared for college in the Portland high school and attended Dartmouth College at Hanover, N. H., graduating in the class of '98. He served with the United States Navy during the Spanish-American War, and later entered the New York office of the Western Electric Co. Mr. Snow remained with the Western Electric Co. until 1913, and when resigning held the position of assistant treasurer. He

then went with the Interstate Company as general auditor in charge of the Minneapolis division and remained with that organization until 1916, leaving to become associated with the Air Reduction Co., Inc. Mr. Snow was made treasurer of the Air Reduction Co., Inc., in May, 1920, which position he held until his retirement from active service in 1927, because of ill health.

Mr. Snow married Ethel Blanche Morton of Portland, Me., in 1904. He was a member of Equality Lodge 940, F. & A. M.

ANNOUNCE COMPLETION OF RESEARCH LABORATORIES

The Fusion Welding Corporation, which operates as the Welding Equipment and Supply Division of the Chicago Steel and Wire Company, Chicago, announces that its new Engineering and Research Laboratories are now completed. These laboratories include a well equipped work room supplied with various forms of alternating and direct current for welding, as well as oxy-acetylene cutting and welding equipment for weld testing and welding rod development. There is also a photographic darkroom equipped with the latest type of metallographic microscope. Still another room contains the necessary desk and office equipment for the engineers, as well as a library and provision for projecting lantern slides and motion pictures. This room affords an opportunity for lecturing to the company's own force of engineers and salesmen on the various technical aspects of the equipment and supplies which the corporation offers for sale. The room has also been used for instruction purposes in connection with select groups of engineers who have been interested in visiting the company's engineering department in order to study some special phases of welding.

It is also announced that they will shortly have full working exhibits, not only at their engineering laboratory in Chicago, but also at several cities scattered across the continent. These exhibits will be located at the company's offices in New York City, Cleveland, Ohio, Kansas City, Missouri and San Francisco, California. Not only will working demonstrations be held showing considerable novel equipment, but new processes will be offered and demonstrated.

AUTO SPEED REQUIRES WELDED STEEL BODIES

One has but to imagine the appearance which would be created by an old-fashioned carriage moving across the country at the rate of sixty miles an hour to appreciate the requirements of present day automobile body manufacture as described by Mr. J. W. Meadowcroft, assistant works manager of the Edward G. Budd Manufacturing Company, Philadelphia, in an article recently published in the American Machinist. In this article the point is well made that when fast cars began to be manufactured the public demanded a look of speed as well as performance. The demand for safety, economy and sound construction made the steel body a natural result. Public taste, however, demanded smoother seams, without rivets, and fortunately large scale production made it possible to secure this at a reasonable cost by the application of resistance welding and gas welding. Production is now on such a large scale as to justify the expense of cutting and forming dies and jigs for assembly and for inspection. Investment in these devices, however, are still a problem because the public demands such frequent changes in shape, causing the manufacturers' equipment to become obsolete in many cases before it is really worn out. Another interesting point mentioned in the article is the fact that the Budd Company maintains a well equipped metallurgical laboratory under the direction of an able metallurgist to cooperate with steel makers in overcoming technical difficulties. They also keep a representative of the Company prominently stationed in the steel district to give the benefit of his wide steel mill experience to the production men on the job in the mills. In their own laboratories they are constantly engaged in research work on sheet metal forming problems. This includes a careful study of the application of all welding processes to the fabrication of their products.

ANNEALING OF WELDED PIPE

In a recent issue of *The Welding Engineer* an abstract was given of an article written by Mr. J. L. Avis for the August 25th issue of the Iron Age. Since the publication of the abstract, there have appeared in the Iron Age a number of communications commenting on the original article. One of the most interesting of these is a detailed comment by Mr. S. W. Miller, of the Union Carbide and Carbon Research Laboratories, Long Island City, New York. He states that his experience has been quite contradictory to the results stated in the original article. Mr. Miller points to the lack of chemical test figures and also check figures both physical and chemical on the material as received. The longitudinal tensile strength of 41,820 pounds is indicated to be abnormally low. Mr. Miller also thinks that transverse tests of the unwelded plate should have been made to check the reported low transfer strength in the welded pieces. The procedure used in making the tensile tests is indicated as being not in accordance with standard practice. It is also pointed out that the test figures do not give a true idea of the elongation. The point is made that the elongation of fractures that break in the weld should not be averaged with those that break outside.

Lacking definite proof of the statement that at ⅝-inch from the center of the weld internal stresses are produced by heating, and knowing that it is possible with the correct procedure to produce welded articles without stresses which make them unsuitable for service, Mr. Miller recommends that the economical method would be to design and weld in such a way as to avoid any need for heat treatment, which is slow and expensive. In his opinion the improvement of the test pieces by heat treatment is not conclusive because of the lack of information as to the strength before heat treatment. If the base metal had been tested both before and after heat treatment and welded pieces from the same plate had been tested in the same way, then it would be more possible to draw accurate conclusions.

PAPER ON ELECTRIC WELDING PRESENTED BEFORE MEETING OF EDISON COMPANIES

At the last annual meeting of the Association of Edison Illuminating Companies, C. L. Ipsen, Engineer in the Industrial Heating and Welding Department of General Electric Company, read a paper dealing with the two subjects of the use of electricity for industrial heating purposes and for welding, with the spot, butt, seam and are processes. The discussion dealt chiefly with the development of the newer forms of welding and with recent developments in the use of arc welding, including a description of a number of automatic welders and of the operation and uses of the new atomic hydrogen process. This paper, with the illustrations used in connection with the discussion, has been printed for distribution by the Association.

SEMET-SOLVAY MEETS GROWING DEMAND FOR WELDED GAS PLANT EQUIPMENT

The successful application of welding to the production of complete water gas sets has led to numerous large orders in recent weeks for this class of equipment. The following orders have been placed with Semet-Solvay Engineering Corp.

A large quantity of welded steel pipe and fittings for Augusta Gas Light Company, Augusta, Ga., and for the Chevrolet plant at Detroit, and also washer cooler and its coils for Citizens Gas Fuel Co., Adrian, Michigan, the cooler being 36 inches in diameter and 31 feet in height.

The sketch shows a fill which was made by electric welding on a 10 inch shaft used in the Tri-City Electric Plant at Moline, Ill. This shaft had worn down in the bearing to 9 inches, necessitating a fill of a half inch to bring it to size. To deposit enough metal on this shaft would have been a very expensive proposition, so we conceived the idea of laying in a half inch round rod a little shorter than the fill. The first rod was placed on the shaft and a weld made on one side all the way across. When this weld contracted it had a

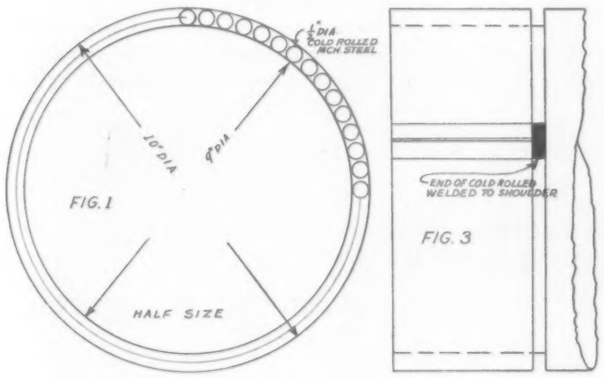


FIG. 1

FIG. 3

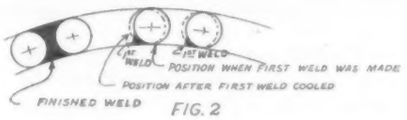


FIG. 2

tendency of rolling the rod back just a little, leaving an opening under the rod, so that when the weld was put in on the other side it was practically solid as shown in figure two. This process was repeated until all the rods were welded to the shaft, then a fill was made making it solid up to the top of the rod, after which a layer was welded over this to give stock for machining. As this shaft ran in water it was necessary that both ends of the weld be perfectly tight, so an opening was left at the shoulder, which was later filled with metal as shown in figure three.

INSTITUTE OF METALS TWENTIETH ANNUAL MEETING

The twentieth annual general meeting of the Institute of Metals, which will be held in London on March 7 and 8, will include several interesting functions. The new president, Dr. W. Rosenhain, F.R.S., will be inducted into the chair by Sir John Dewrance, R.B.E., and will deliver his presidential address. Afterwards sixteen papers will be read and discussed. These include contributions from metallurgists in Germany, Japan and the United States, as well as Great Britain. Following the papers there will be a dinner and dance at the Trocadero Restaurant, also the formal opening of the new offices and library of the institute at 36 Victoria St., London, S. W. I. The official program of the meeting includes a notable list of new members—123 in all—which brings the membership close to the 2,000 mark. It is striking to note what a large proportion of the new members reside abroad. An election of members is announced to take place on Feb. 22; particulars of membership, which now covers the period ending June 30, 1929, are obtainable from the secretary, Mr. G. Shaw Scott, M.Sc., 36 Victoria St., London, S. W. I. Among the latest applicants for membership are M. Andrè Citroën, the famous French motor car maker, and representatives of the French mint and Ministry of Marine.

A. I. E. E. HOLDS ARC WELDING SESSION

In connection with its annual winter convention, the American Institute of Electrical Engineers have set aside the afternoon of Friday, February 17th, for a full session on arc welding. The papers presented in this session are as follows:

Effects of Surface Materials on Metallic Arc Welding Electrodes, by J. B. Green of the Fusion Welding Corporation, Chicago.

The Influence of Surrounding Atmosphere on the Arc, by P. Alexander, the General Electric Co., Schenectady, N. Y.

Arc Welding Structures and Bridges, by A. M. Candy, Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

Welding and the Manufacture of Large Electric Apparatus, by A. P. Wood, General Electric Co., Schenectady, N. Y.

The meeting is being held at the rooms of the A. I. E. E., in the Engineering Societies Building, 33 W. Thirty-ninth St., New York City, and a special invitation has been extended to members of the American Welding Society to attend the meeting.

PLANS READY FOR WELDING EXPOSITION IN CALIFORNIA

Twelve national societies and associations having branches in the far West are arranging to participate in the program for the Western Metal Congress, to be held in Los Angeles, California, January 14th to 18th, inclusive, 1929, under the auspices of the American Society for Steel Treating. These organizations plan to make this congress an educational feature which will be the most important and far-reaching for assembly in the interest of the metal industries of the Western states. Concurrently with this metal congress, the first Western States Metal and Machine Tool Exposition will be held in the Shrine Auditorium of Los Angeles. This exposition will be comparable in size and arrangement to that held in Detroit last Fall. It will be a complete cycle of the metal industry, including raw materials, machine tools, heat treating apparatus, inspection equipment, foundry supplies, oil field tools, welding and cutting equipment, small tools, machinists' supplies, and etc. The interested organizations in the far Western states are showing a splendid interest and enthusiasm over these events and approximately a hundred Eastern firms have already indicated that they will participate in the exposition. Additional details can be secured from Mr. W. H. Eisenman, secretary of the American Society for Steel Treating, 7016 Euclid Ave., Cleveland, Ohio.

LECTURE ON SAFETY IN WELDING AND CUTTING

On Tuesday evening, February 7th; Mr. J. I. Banash, consulting engineer, addressed an industrial safety meeting at, South Chicago Masonic Temple under the auspices of the Chicago Safety Council. The subject of Mr. Banash's paper was "Safety in Welding and Cutting." This was followed by demonstrations of apparatus. The meeting was open to foremen, workmen and committeemen. The talk opened with a brief history of the carbide industry, leading up to the present uses of carbide in homes and industrial plants. Attention was then called to the various types of equipment used in welding and cutting, and particular emphasis was placed on the advisability of using standard types of equipment which carried the approval of the underwriters' laboratories, from a safety viewpoint. Several practices in connection with the operation of welding and cutting torches, regulators, generators and etc., were then explained. There were over three hundred men present at the meeting and the interest was so high that nearly two hundred of them remained to participate in the discussion of the paper long after the regular hour for adjournment had arrived.

CLEVELAND TRADE STUDENTS SEE OXYGEN FILM

The Cleveland Welding School, 2094 East Nineteen St., Cleveland, Ohio, under the able management of R. K. Randall and E. T. Scott, is rapidly extending its influence for better welding through the industrial district of that city. An example of this is an invitation recently extended to present and former students of the industrial class of the Cleveland School of Technology and the sheet metal group of the Cleveland Trade School to assemble at the Cleveland Welding School to learn something about oxy-acetylene welding. The meeting took place on Thursday evening, January 26th. The principal feature of the program was the showing of the motion picture film "Oxygen the Wondermaker." This was followed by a talk and demonstration of liquid air by Mr. G. E. Harke of the engineering department of the Air Reduction Sales Company. Mr. Randall reports that these youthful engineers and tradesmen showed a great deal of interest in the oxy-acetylene process, especially with respect to its possible applications to work which they may have to supervise in the future.

NEW MILBURN SPRAY GUN

The Alexander Milburn Company, Baltimore, Maryland, has recently developed a new spray gun for painting departments, sign shops, photographers and for general use where a fine spray is required. The extremely fine mist or spray procnred with this gun is desirable for decorating, shading, high lighting and blending of colors now in service, also touching up scratches, mars or dents in automobile bodies, machinery or other equipment requiring a fine finish. The new gun, known as the Type K, Jr., is said to be quick in operation and very convenient. It will operate on as small as one horse power air compressor.

BOOKLET ON ECONOMICAL GAS CUTTING

"Factors Involved in Economical Gas Cutting" is the title of a booklet which has just been published by the Air Reduction Sales Company, 342 Madison Ave., New York City. This booklet is a reprint of a paper by Mr. J. L. Anderson of the above company's engineering research department, which was presented at the Welding Conference at the University of Minnesota and later before the Philadelphia Section of the American Welding Society. The author does not undertake to give a complete analysis of all the factors involved in cutting, but he has covered the principal ones which effect the economy of the work.

BOOKLET ON WELDED PIPING

"Welded Piping" is the title of a new 28-page booklet recently published by the Linde Air Products Company, New York City, and now available for distribution. The purpose of the booklet is to show how the oxy-acetylene welding process can be used to improve pipe installations which have formerly been made in accordance with standard plumbing practice. The adaptability of the welding and cutting torches to every phase of pipe welding is not only explained but fully illustrated so as to show just what savings can be made by welding instead of using fittings and how various kinds of pipe lines can be improved by substituting the strong, tight welded joint for the old-fashioned fitted joint which is so subject to leakage.

SPECIFICATIONS FOR WELDERS' HELMETS

There has just been published by the Federal Specifications Board, the Bureau of Standards, Washington, D. C., Specification No. 544, for the use of the departments and independent establishments of the government in the purchase of welders' helmets. The title page of the specification indicates that the technical requirements of this specification shall become mandatory for all departments and independent establishments of the information not later than March 28, 1928. The specifications are very complete in detail as to the construction and general requirements of welders' helmets and also as to methods of inspecting and testing.

WELDING SHOP ADVERTISING PROVES BIG SUCCESS

The results of the advertising issued by Storts Welding Company, Meriden, Conn., described in the last issue, have been so encouraging that this company is now mailing every month a sheet called "Storts-Welded-Facts," describing in very readable style a number of typical welding jobs executed by this shop. Their last mailing includes an illustrated folder called "Evidence," which presents convincing evidence of what welding can accomplish in production and in maintenance. Such advertising is apparently "pulling" well for this progressive welding company.

NEW FOLDER DESCRIBES "ALTERNARC" WELDER

An interesting eight-page folder describing alternating current portable cutting and welding apparatus has recently been published by the Electric Arc Cutting & Welding Co. of Newark, New Jersey, with sales offices in Detroit.

According to C. J. Holslag, general manager of the company, the folder is of special interest to welding engineers and operators, and to manufacturers having use for improved arc welding equipment. It discusses the development and advantages of alternating current arc welding, and describes the different models of Alternarc welders and their various uses. It also contains a number of illustrations of actual jobs done with this equipment.

The Electric Arc Cutting & Welding Co. have a complete line of welding accessories including Electrodes, Welding Helmets, and Electrode Holders. Mr. Holslag is author of a complete and authoritative work on arc welding entitled the "Welding Handbook." Extracts from this valuable book as well as instruction leaflets will be published from time to time and sent upon request to customers and those interested in welding.

ALL IN THE DAY'S WORK

By A. M. McCutchan

I have welded busted motor blocks,
On tractors, cars and such.
I have welded locomotives,
And I didn't worry much.

I have welded water towers,
Structural steel, and pipe lines long,
I have welded on big steam ships,
And I went on with my song.

I have welded in the sunshine,
I have welded in the shade,
Every thing from dredgeboats,
To a safety razor blade.

I have scorched my hands, and burned my feet,
And seared my face till red,
Many times I've worked all night,
And never went to bed.

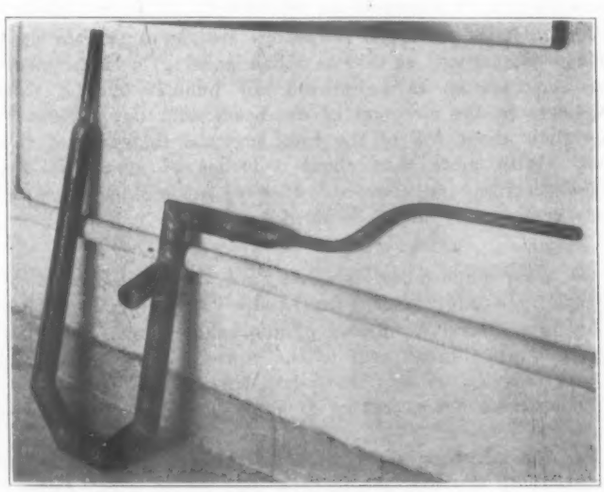
I have welded steel and cast iron,
Copper, brass and armor plate,
But the damdest job I ever had,
Was an old burned out stove grate.

NEW YORK MASTER PLUMBERS STUDY WELDING FOR DOMESTIC PIPING

The increased recognition accorded the oxy-acetylene welding process by educational institutions and trades bodies was illustrated at the first annual three day institute for the New York State Association of Master Plumbers, at the College of Engineering, New York University, New York City, held January 23 to 25 inclusive.

The welding features of the institute included a daily illustrated lecture on "Welded Small Diameter Pipe for Residence Installation," by R. B. Aitchison, of the Linde Air Products Company, in which was described the first house in New York City that had its plumbing installed without screwed joints; exhibit of welded specimens (as shown in illustration), and demonstrations of welding a typical steam heating installation for a small residence, with records kept of oxygen and acetylene consumption, and cost per joint; and an address on "Oxy-Acetylene Welding" by S. W. Miller, Consulting Engineer, Union Carbide & Carbon Research Laboratories. Other subjects of interest in connection with plumbing and heating were covered.

Left: Showing Section in Which Welding Demonstrations Were Conducted, with Various Samples of Fittings and Pipe Welds Displayed. Right: Master Plumbers Viewing Welding Demonstration.



Pipe Special Showing Various Types of Joints Used in Heating System, Including Reducer, Obtuse Angle Branch, Swedged Reducer and Hot Bend.

The welding exhibit and demonstrations were conducted through the cooperation of the Linde Air Products Company and associated companies at the invitation of the university authorities, and were in charge of Mr. R. W. Boggs.

Attendance was in excess of five hundred, which testified to the keen interest in oxy-acetylene welding as applied to plumbing and heating installations.

TENTH NATIONAL METAL EXPOSITION TO BE HELD IN PHILADELPHIA

At the tenth annual National Metal Exposition, to be held at the Commercial Museum, Philadelphia, October 8-12, 1928, a large block of spaces are to be reserved for the Welding and Cutting Exposition, so that manufacturers in the welding industry will be grouped together again as last year at Detroit. This arrangement proved so satisfactory that it is being definitely planned to hold the convention of The American Welding Society and the Welding and Cutting Exposition during National Metal Week.

It was found at the Detroit show that the welding exhibits drew heavily from the visitors who attended the other sections of the exposition. The result was a new interest in welding on the part of many plant and designing engineers who had an excellent opportunity to observe what is actually being accomplished with all of the welding processes.

A number of the larger manufacturers in the industry have already reserved space, and indications are that the welding section will be even larger and more interesting, with more firms represented than at the 1927 exposition. Reservations should be sent to W. H. Eisenman, secretary, American Society for Steel Treating, 7016 Euclid Ave., Cleveland, Ohio.

CHICAGO SECTION OF A. W. S. DISCUSSES WELDING OF LIGHT GAUGE SHEETS

The February meeting of the Chicago Section of the American Welding Society, held in the rooms of the Western Society of Engineers on the evening of February 3, was opened with a motion picture film on "Making Mazda Lamps," after which Mr. F. J. Mauerer of Air Reduction Sales Company spoke on "Oxy-Acetylene Welding of Light Gauge Sheets by Simple Mechanical Methods." Mr. Mauerer, who has been in the welding industry since its earlier days, covered the topic very thoroughly, pointing out the advantage of using suitably designed jigs and other mechanical helps to hold the work in place, to take care of expansion and contraction, preventing distortion and stresses, and to control the volume and intensity of the welding heat of the work, showing, for example, the desirable and undesirable features of having the region of the weld backed up by the metal of a jig or other support.

Following Mr. Mauerer's talk, the meeting was opened for discussion and a number of questions arising from every day practice were asked by those present, and answered by Mr. Mauerer and others.

A. I. S. C. PUBLISHES HANDBOOK OF STEEL CONSTRUCTION

The American Institute of Steel Construction has just published a new Handbook containing 384 pages of data indispen-

sable to the designer and specification writer. Its contents include the A. I. S. C. Standard Specification for Structural Steel for Buildings, the A. I. S. C. Standard Specifications for Fire-proofing Structural Steel Buildings, and the A. I. S. C. Code of Standard Practice.

There will also be found in the Handbook a large amount of additional information previously unobtainable in printed form, or obtainable only from widely scattered sources. Data regarding the new shapes recently produced by various rolling mills is complete up to date of issue. There is also an abundance of tables on strength of materials, formulae for beam loadings, properties of sections, dimensions and functions, and general mathematical tables.

Copies may be obtained at a cost of $1.50 from any member of the American Institute of Steel Construction, or from the office of the Institute at 285 Madison Ave., New York City.

METAL RADIOSCOPY

By Herbert R. Isenburger*

The method of examination, which I shall designate "Metal Radioscopy" is based on the penetrating power of the X-rays. It refers to the testing of raw materials or half finished manufactures of high value like castings, soldered or welding seams, etc., for faults within materials such as aluminum, zinc, tin, copper, brass, iron, steel, porcelain, etc.

The piece of work lies between focus and plate (or fluorescent screen). An irregularity in the density of the plate not caused by an exterior treatment or in the flourescence of the screen, indicates such faults. Figure 1 schematically shows a radiographic arrangement for metal radioscopy with photographic plate.

With larger pieces and increased tensions, the fogging influence of the stray radiation arising in the piece under investigation is highly remarkable. The outlines become soft, the difference in the opacity diminish owing to the general fog and thereby the visibility of the contrasts become reduced. To some extent this drawback can be removed by the employment of movable diaphragms such as the Bucky diaphragm used in medical diagnostics if one agrees to considerably lengthened durations of exposure.

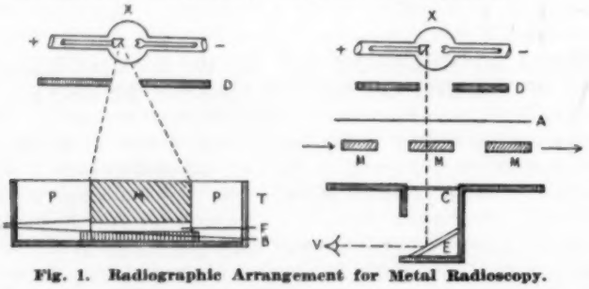


Fig. 1. Radiographic Arrangement for Metal Radioscopy.

A—Movable table for the automatic passing of the material under investigation before the fluorescent screen.
B—Sheet brass as protection against selfradiation of the lead emitted backwards.
C—Fluorescent screen.
D—Lead diaphragm.
E—Mirror.
F—Dublitized film.
M—Material for research.
S—Intensifying screens.
P—Lead shot as protection against secondary rays from the walls or from objects of the testing room.
V—Viewer.
T—Lead tank.
X—X-ray tube.

For the purpose of metal radioscopy, relatively high tensions on the X-ray tube are required, if the limits of a reasonable duration of the exposure shall not be exceeded, i.e., we want apparatus and tubes for high tensions and capacity.

The target-plate-distance, too, requires a high number of milliamperes discharging through the tube and therefore a great penetrating power and intensity of the radiation. The distance has to be generally a great one, in order to obtain with the large extension of the focus sharply-defined outlines of the faults. Small target-distance produces haziness of the minor faults due to the breadth of the focus, which makes it difficult to recognize them. Therefore, tubes of a great capacity with a focus in the form of a dash should preferably be taken, which are put in in such a manner that their focus seen from the object seems like a point. However, these tubes have a draw-back that they can stand but relatively low charges.

An excessive increase of the voltage is not advisable, as the constrasts-producing effect of the rays decreases in proportion to their hardness. Recent researches show that the eye is most sensible to differences of the density in the range of a base opacity of about 0.6 to 1.0 on the photographic plate.

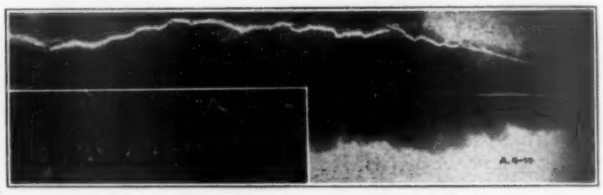


Fig. 2. Welded Joint of Boiler Plate (Fluoroscopy). Insert. Photographic View of Same Joint.

With 20-inch target-distance, 4 ma. and 150 kv. continuous current voltage, in 40 seconds a perfect density (density after deduction of the fog) of 0.6 behind 1 inch of iron can be obtained by using films with an intensifying screen. Behind 2 inches of iron, 225 kv. and under otherwise the same conditions, the same opacity can be obtained in about 35 minutes.

Figure 2 shows an arrangement as made with pieces of a small thickness or of an inferior ordinal number (low absorption coefficient), where the end radiation emitted behind the pieces under investigation is still great enough to stir up a fluorescent screen to an effective fluorescence radiation.

The limits of the metal radioscopy are already within sight today. Formations as thin as a hair existing in larger pieces are very seldom to be proved, air bubbles only if their thickness in the direction of the beam does not amount to less than about 5% of the total material thickness at this spot. With more than about 5 inches of aluminum, 2½ inches of iron and about 3 inches of brass satisfactory results are scarcely to be obtained.

Of great importance, however, are the examinations by X-rays of castings (except lead), which frequently have blow holes or enclosures. These photographs, known as "Exographs," are a great help to the entire metal industry and in the near future any up-to-date concern will find it not only desirable but necessary to apply X-ray inspection as a matter of routine.

For the investigation of welded or riveted joints on boiler connections, etc. too, the method may be of great value.

President, Herbert R. Isenburger, Inc.

J. B. GREEN ON LECTURE TOUR

J. B. Green, President of the Fusion Welding Corporation, 103rd Street and Torrence Avenue, Chicago, Illinois, is spending much of the month of February on a lecture tour. He will lecture at various welding conferences held under the auspices of several of the State Universities, and also at the annual meeting of the American Institute of Electrical Engineers in New York City. Mr. Green's lecture is based on the research work done by the engineering department of the

company with which he is associated. It covers a study of the flow of welding metal in both oxy-acetylene and metallic arc welding, and is illustrated by slow motion moving pictures taken with invisible infra-red light. Shortly after this lecture tour is completed Mr. Green plans to take a vacation trip, accompanied by Mrs. Green, which will include Havana, Cuba, and Mexico City, Mexico.

STOODY COMPANY TAKES TO THE AIR

In the December issue of "Fusion Facts," a sixteen-page monthly issued by Stoody Company, Whittier, California, is a picture of their new biplane and its pilot. Occasional delivery by airplane proved so successful for this company that they have now purchased their own Lincoln-Page machine and have retained Bob Cochran, who has more than 3000 flying hours to his credit, to man the plane which carries pilot and two passengers or their equivalent in freight. A landing field and hanger adjoin the plant at Whittier. With this service, the factory is only an hour and ten minutes from its Bakersfield branch and twice that to Oakland.

TWO NEW MILD STEEL ELECTRODES

The Fusion Welding Corporation, 103rd Street and Torrence Avenue, Chicago, Illinois, announces that it has completed the development work on two new mild steel welding electrodes which are now released for distribution by the company's sales department. On account of their color, these electrodes will be known as "Blue Streak" and "Yellow Jacket," respectively. The "Blue Streak" is described as an exceptionally fast flowing electrode, melting rapidly and, at the same time showing great arc stability. It is said to be especially suited to the welding of the medium and lighter gauge plates as well as sheets and is a full flux coated electrode. The "Yellow Jacket" is a surfaced electrode, and is designed to give extreme penetration when used with high current on heavy material. The makers report that half-inch mild steel plates have been successfully welded without beveling the edges, at a rate of over twenty feet per hour. Both of these electrodes are available for shipment from the main plant at Chicago, and shortly will be obtainable from the company's warehouse stocks in New York, Cleveland, Kansas City, San Francisco, Los Angeles and Seattle.

BAIN-BEAIRD PUBLISHES MAP OF THEIR TERRITORY

The Bain-Beaird Co., Inc., of Shreveport, Louisiana, has prepared a complete wall road map of the territory they are serving in Louisiana, Mississippi, Arkansas, Oklahoma, and Texas. The map also bears pictures of the company's oxygen and acetylene plants, the machine shop, and the steel fabricating palnt, as well as their wide line of products, including acetylene, oxygen, carbide, welding and cutting apparatus, generators, structural steel, boiler and plate work, tanks, machine work, and tank car repairs.

BRITISH OXYGEN COMPANY ISSUES BOOKLETS ON WELDING AND APPARATUS

The welding and cutting department of The British Oxygen Co., Ltd., London, England, has published three booklets, one, a 36-page catalog describing the manufacturer's apparatus and illustrating numerous large scale applications of the oxy-acetylene process; another practical booklet of 64 pages, "Hints on Gas Welding," and a third of the same size containing "Hints on Oxygen Metal Cutting." These books are all excellently prepared and illustrated.

LARGE WHEEL TRUCK FOR OXY-ACETYLENE EQUIPMENT

After thorough tests in field and shop, a new type of two-wheel truck has been put on the market by the Oxweld Acetylene Company, 30 East 42nd Street, New York. Increase in wheel size was a primary consideration in the design, larger wheels making the truck much easier to handle.

The illustration shows the new truck equipped with 24-in. steel wheels, having 3 by ⅜-in. grooved tires and a case iron hub. The hub is bored to fit the cold rolled steel axle and a grease cup is provided. Lubrication is of particular importance in overland pipe line work where the truck may be hauled long distances at fairly high speed behind a motor truck.

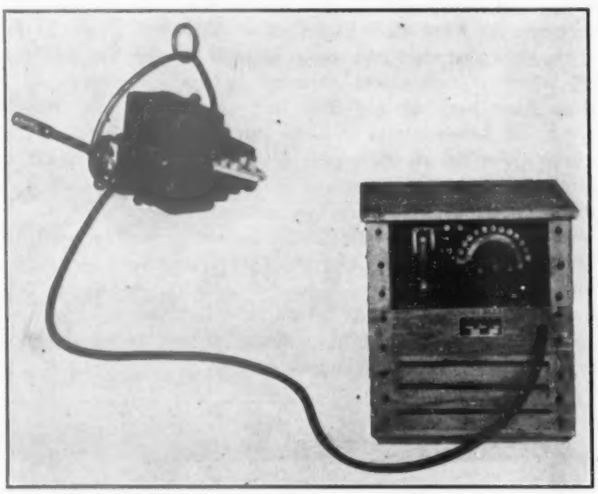
Other improvements have been made. The handle is continuous and the upper portion is bent back about eight inches so that the truck can be eaily handled by an operator of small stature. The tool box is larger and is provided wtih a cover and a holder for extra blowpipe tips.

Where 24-in. wheels are not required, 14-in. wheels may be used instead merely by changing the position of the axle to the lower set of holes which are already drilled in the frame. The same frame and axle can be used with either size wheels. No grease cups are necessary with the smaller wheels.

PORTABLE SPOT WELDER FOR FABRICATING STEEL MESH

Allan Manufacturing & Welding Co., Inc., 726 Washington St., Buffalo, N. Y., have placed on the market the Allan Portable Spot Welding Outfit for the welding of reinforcing mesh required in the manufacture of concrete pipe, concrete piles and other concrete products.

Electric spot welding of parts joined has proved greatly superior to the former method of tying. The welded product is more durable, and cracking is eliminated. Rupture



Allan Portable Welding Machine.

of concrete pipe often occurs where the steel reinforcement is joined by tying, and, according to the makers, the welding of the overlapping part of the reinforcement eliminates this drawback and results in a pipe of much greater strength, affording an endless reinforcing cage, which has every joint welded, and all circumferential laps likewise welded, thus securing maximum strength.

The outfit consists of the spot welding apparatus guided by the operator, and the heat control transformer. The welding apparatus is generally suspended from two uprights, having a track across their top, readily permitting the ap-

paratus, by means of a pulley or roller, to be moved back and forth, eliminating the moving of cage. The control transformer is for the purpose of increasing or decreasing the heat, depending, of course, upon the size, or diameter

Cages Being Welded by Allan Portable Welding Machine.

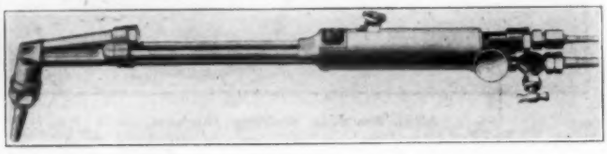
of the wires or rods to be welded. According to the manufacturer, both the welding apparatus and control transformer are of simple, rugged construction throughout, and practically fool-proof. No artificial cooling devices, such as water, oil or forced air, are required. The outfit is constructed for any primary volts up to 550 and any cycles and phase. Total weight of standard outfit with capacity of two 3/8-inch diameter rods is less than 500 pounds. Outfits can be constructed for wires or rods up to ½-inch diameter.

IMPROVED OXYGEN CUTTING BLOWPIPE

A new cutting blowpipe, known as type C-14, which will not backfire even under the most severe operating conditions, has been added to the line of the Oxweld Acetylene Company, 30 East 42nd Street, New York.

This blowpipe uses the same nozzles as the Oxweld type C-2, which it resembles; although several improvements in design have been made. The three gas tubes are straight, having no bends either outside or inside the handle. The cutting valve is of the same design as has been used on the type C-6 for many years and is now used on all hand cutting blowpipes of the same make.

Some time ago the small needle valve bodies used for acetylene on the cutting blowpipes were improved by making them pressure forgings. Now, in addition to these, both the head and the rear body of the type C-14 are also pressure forgings, instead of castings, giving better appearance, increased durability and lessened weight.



Oxweld Type C-14 Cutting Blowpipe.

Interchangeable nozzles are provided so that the blowpipe may be used with either medium or low pressure acetylene. Obviously the medium pressure nozzle cannot be used with low pressure acetylene, but the low pressure nozzle can be used with a medium pressure acetylene supply if low pressure is maintained in the hose and blowpipe. To accomplish this, the regulator should be adjusted to give a flame showing an excess acetylene cone not more than 1 in. long when the acetylene valve on the blowpipe is wide open. The acetylene valve should then be adjusted to obtain the neutral flame.

Reports of exhaustive laboratory and field tests made by the engineering department of the manufacturer have satisfactorily demonstrated the correctness of these new features of design.

NEW FEDERAL SPOT WELDER CATALOG

The Federal Machine & Welder Co., Warren, Ohio, have just issued Bulletin 250, which describes and illustrates the Junior Type Spot Welder, as adapted to various classes of work, with different arrangements of the arms and electrodes. There are also illustrated the Junior Double Arm Spot Welder and the Automatic Type Welder, the latter equipped with a ¾ H.P. 3-phase A.C. motor and a six-speed gear box arranged to give speeds of 60 to 120 spots per minute. The machine can be furnished for belt drive if desired.

News of the Welding Trade

In publishing the item in the January issue regarding the book published by The National Association of Ornamental and Bronze Manufacturers, the address of the association was omitted. As we have received requests for this interesting booklet, we wish to refer those who are interested direct to the offices of the association at 622 Broadway, Cincinnati, Ohio.

National Oxygen Company has moved its main office to larger quarters at suite 756-757, 29 S. LaSalle St., Chicago, Ill.

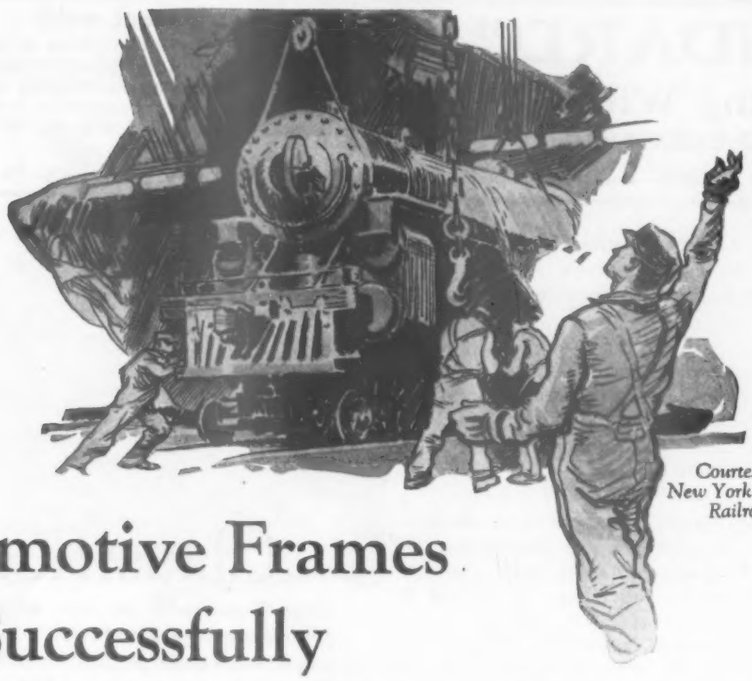
Wilson Welder and Metals Co., Hoboken, N. J., advises that in a recent list of appointments of distributors of its welding machines the representation at Boston should be Austin Hasting Co., Inc., instead of Joseph T. Ryerson & Son, Inc. Its welding wire distributor at Jacksonville, Fla., should be J. G. Christopher Co. instead of J. G. Christopher.

A. M. MacFarland has been added to the staff of the Lincoln Electric Co., Cleveland, as general sales and development engineer. During the early years of the war he was engaged in consulting engineering practice, and later was assigned by the Navy Department to supervise the construction of marine propelling machinery for naval units. After the war he became interested in the design and development of percussive and automatic arc-welding equipment, and during the last seven years obtained about 30 patents in the welding field.

The name of the Gunn-Rush Manufacturing Company, Tulsa, Oklahoma, has recently been changed to the Rush Construction & Manufacturing Company, under the management of A. W. Rush and R. B. Hansen. This company specializes in pipe line construction and also manufactures a portable acetylene generator.

Peter Gillespie, Professor of Civil Engineering of the University of Toronto, is in charge of a series of tests of the comparative value of welding and riveting in steel construction which is being carried on at the University under the direction of the American Bureau of Welding. It is expected that complete reports on these tests will be available later in the Spring.

E. Wanamaker, Electrical Engineer of the Rock Island Lines, Chicago, Illinois, contributed an article in the January issue of Railway Purchases and Stores on the subject of "Welding Savings," in which he points out the enormous savings that have been made by railroad companies through the application of all of the different welding processes.



Courtesy of New York Central Railroad

Locomotive Frames Successfully Welded with Tobin Bronze

No stronger proof of the dependable strength of Tobin Bronze welds can be offered than that locomotive frames repaired three years ago with this trade-marked bronze are still in daily use and that locomotive cylinders welded with Tobin Bronze ten years ago are today giving satisfactory service.

Several of the largest railroad repair shops have adopted Tobin Bronze welding as standard practice in repairing broken locomotive frames and cylinders. The low welding temperature required when applying Tobin Bronze usually eliminates pre-heating and dismantling; thus making it possible to repair many engine breaks on the tracks with the least possible interruption to service.

Tobin Bronze welding rods are made exclusively by The American Brass Company and have the trade-mark "Tobin Bronze" rolled in every rod. They may be obtained from leading distributors of welding supplies.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LIMITED
New Toronto, Ontario

TOBIN BRONZE
REGISTERED U.S. PATENT OFFICE
WELDING RODS

EXCLUSIVELY AN ANACONDA PRODUCT

"STANDARD"
Welding Wire
GAS AND ELECTRIC
A grade for each type of work—send for samples.

for sound permanent welds : : lower costs
Our costs are considerably under those of large industrial centers; ours is a one-profit wire sold direct to user from our own mills exclusively devoted to making of welding wire from raw material to finished product—hence our extremely low prices for wire that is definitely superior. Adopted exclusively by many large users.
Prices on request.
Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

A. F. Jenkins, President of the Alexander Milburn Company, Baltimore, Maryland, and Mrs. Jenkins, have just returned to the United States from a holiday tour in Europe which included visits to England, France and Italy.

The Keith Dunham Company, Chicago, report the completion of the installation of an Oxeco oxygen producing plant at the Chicago works of the Carbo-Oxygen Company. This is the eightieth oxygen producing plant which the Dunham Company has installed in the United States.

The Fusion Welding Corporation, Chicago, Illinois, announces the appointment of Mr. E. J. Shuler to its engineering staff. Mr. Shuler comes to the company with eight years' experience in New Orleans, where he was in full charge of welding for the New Orleans Public Service Corporation, and did a great deal of development work in connection with the different welding and cutting processes.

J. G. Norris, Central Steel & Wire Company, Chicago, Illinois, is spending the latter part of the month of February on a vacation trip in Florida.

The International Oxygen Company, with general offices at Newark, New Jersey, announces that it has purchased property in Buffalo, New York, and is proceeding with the erection of a gas plant to serve that territory.

S. W. Miller, of the Union Carbide & Carbon Research Laboratories, Long Island City, New York, presents a paper entitled "Some General Thoughts on Fusion Welding," before the first semi-annual meeting of the American Society for Steel Treating held at the Mt. Royal Hotel, Montreal, February 16th and 17th.

The Victor Oxy-Acetylene Equipment Company, San Francisco, California, announces the appointment January 1st of Mr. E. L. Mathy as director of sales. Mr. Mathy was formerly connected with the Air Reduction Sales Company on the Pacific Coast.

At the ordinary meeting of the Institution of Welding Engineers, London, held at Caxton Hall, January 23rd, a paper on the subject of "Electric Welding Repairs to Inflated Gas Holders," illustrated by lantern slides, was read by A. E. Plumstead.

H. E. Rockefeller, of the Linde Air Products Company, contributes an article on the subject of "Procedure Control in Pressure Vessel Welding" to the February, 1928, issue of Mechanical Engineering.

The Lincoln Electric Company, Cleveland, Ohio, announces that it has retained the services of Mr. A. M. MacFarland as General Sales and Development Engineer. He will devote his efforts to the development and special application of automatic carbon arc welding, with headquarters at Cleveland. Mr. MacFarland has had wide experience in general consulting practices and also to the design and development of percussive and automatic arc welding equipment.

R. E. Kinkead, Consulting Engineer, who is well known in the industry for his work in the development of applications of arc welding, has contributed a very interesting series of articles to recent issues of the Iron Trade Review on the general subject of "Can Business Benefit from Principles of War?"

It is reported that the Linde Air Products Company, New York City, has recently begun the work on a two-story oxygen plant at Grand Rapids, Michigan.

The Equipment and Supply Company, manufacturers' agents, Louisville, Kentucky, announces the opening of offices and display rooms centralizing all forms of mechanical equipment, machinery, construction materials and supplies. Agencies and territories are solicited for such products.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

For Sale—200 ampere, 60 cycle, 220 volt Alternarc welder as good as new, $225. Also a similar 300 ampere Alternarc welder, $350. Goodman Electric Machinery Company, 126 Green Street, Newark, New Jersey.

AGENCY

Wanted—General agent for Belgian manufacturer of high class coated electrodes. Write to Soudure Electrique Autogene, 90, Pont-de-Luttre, Bruxelles.

ELECTRIC ARC WELDERS WANTED:

Men thoroughly experienced in electric arc welding; must be familiar with pressure work. Applications by mail should contain full details of experience and references. Pacific Steel Boiler Corporation, Bristol, Pennsylvania.

Position Wanted—Salesman, wide acquaintance Metropolitan New York district. Desires exclusive selling arrangement. Acetylene apparatus, lights, oil burners and rods. Address Box 143, care of The Welding Engineer.

Position Wanted—As sales and service man for reputable manufacturer of welding apparatus and supplies; oxy-acetylene preferred. Have had eighteen years' experience as gas and electric operator on production and job shop work. Also have directed experimental work. Address Box 144, care of The Welding Engineer.

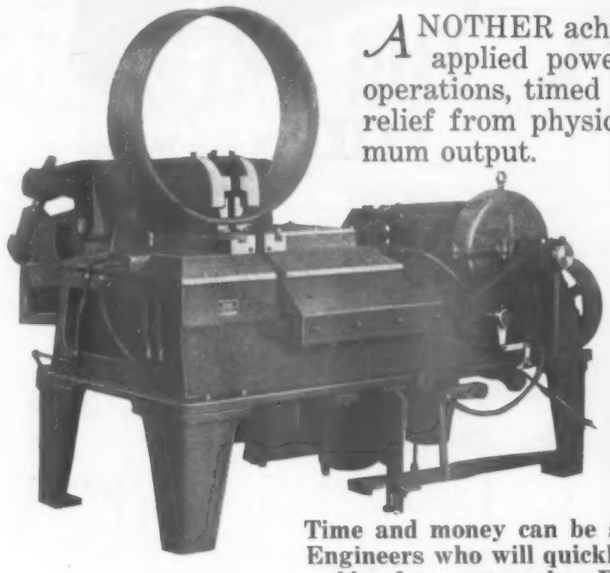
Position Wanted—Welder skilled on gas and electric (arc). 10 years' experience job shop and automobile; also shipyard. A1 references. Willing to go anywhere. Address Box 145, care of The Welding Engineer.

Position Wanted—Expert demonstrator and service man. Five years teacher acetylene welding. Three years demonstration work. Young man, single. Prefer Eastern district. Address Box 146, care of The Welding Engineer.

Position Wanted—Have had 14 years' experience in all branches of electric welding, as well as some oxy-acetylene welding. Have had charge of cutting and welding departments of job shops and ship yards, and am familiar with welding production methods. Will go anywhere in North or South America. Address Box 147, care of The Welding Engineer.

Federal

Welding 200 8" Rims Per Hour!



ANOTHER achievement of the efficiency of automatically applied power to industry. Power driven automatic operations, timed with clock-like regularity and consequent relief from physical strain of the operator, produce maximum output.

The Type No. 82 Automatic Butt Welder, designed originally for automobile rim production, is finding increased application in other fields where mass production is demanded. It has been successfully applied to the welding of automobile parts, farm implement parts and concrete pipe reinforcements. It has further application to a wide line of fabricated steel articles. It may pay you to investigate the application of the new Type No. 82 Automatic Butt Welder to your work.

Time and money can be saved by following recommendations of Federal Engineers who will quickly and freely advise you as to the proper type of welder for your needs. Federal makes all types of electric spot, butt and seam welders.

THE FEDERAL MACHINE & WELDER COMPANY

WARREN, OHIO, U. S. A.

BRANCH OFFICES IN ALL PRINCIPAL CITIES

Our Swedish Iron Welding Wire

meets two vital welding requirements

1. Easy working under the flame.
2. Weld metal which is *strong* and *ductile*.

There is no better rod for gas or electric welding

Our product is not a domestic imitation of Swedish Iron. It is not manufactured in this country. We import it direct from the mill in Sweden. Its fine working qualities are largely due to manufacturing processes which yield an iron practically free from impurities.

ALL SIZES CARRIED IN STOCK

If you haven't tried Genuine Swedish Iron, send us a trial order

THE BISSETT STEEL COMPANY

CLEVELAND OHIO

WELDING RODS

"Seneca Gas Weld"
"Seneca Electro Weld"

These rods are made from specially selected stock and processes. Uniform Temper, Analysis, Gauge and Finish.

Special Soft—Medium Hard—Extra Hard

Seneca Rods are shipped to you in coils, or in straight lengths as you wish, in:—

Black—Bright—Coppered Finish Flux Coated

Your inquiries will receive prompt attention.

The Seneca Wire Mfg. Co.

Established 1905

Fostoria, - - - Ohio

WISSCO GRADE NO. 2 SPECIAL. PROCESSED ELECTRODES
Developed for particular consumers; i. e. Railroads, Shipyards, Boiler Makers, etc., for use on general repair work.

NO RIVETS--NO FITTINGS ONLY WISSCO WELDS ON THIS LARGE TANK AND PIPE LINE

An ice plant with a capacity of 500 tons has been constructed for the Canadian Government at Toronto, by the Carbondale Absorption Machine Co. Ltd., of Montreal.

The ice tank is 70' by 32' by 5.5', of ¼" plate. No rivets were used and no standard tees were employed as fittings; the entire job, including all cross lines from the main line, was electrically welded by the Thompson Welding Co., Limited, of Toronto, with Wissco No. 2 Special Processed Electrodes. A pressure of 180 pounds is required in the ammonia line, and the welds were tested to stand a pressure of 300 pounds.

Each grade of Wissco Welding Wire is composed of special analysis, especially processed wire produced for a certain type of welding.

All Wissco Welding Wire is tested for chemical, physical and welding properties before being passed. Uniformity and proved welding ability are thereby insured.

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NEW YORK CITY

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Please send me your booklet "Wissco Welding Wire."

Name ..... Address .....

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You sure get more work done when your welding rods are clean and the work's done better in the bargain. FRE-FLO Rods are all *clean*—no trade name marked on the rods causing sand to adhere, no rust, no breakage.

I'm strong for the way they ship FRE-FLO in 100 lb. boxes.

[Want a sample of FRE-FLO? Just drop us a post-card.]

Big Jim (MASTER WELDER)

FRE-FLO rods are sold only through distributors. A few desirable territories are still open. Correspondence from distributors is invited.

The Atlas Foundry Company
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Arc Welding Handbook

BY C. J. HOLSLAG

A simple and practical manual of instruction in arc welding. The beginner is led step by step to complete mastery of the process. The supervisor is furnished a reliable guide for the training of new operators. The experienced operator is posted on principles which were overlooked in his first teaching.

250 Pages

Well Illustrated

Price, $2.00

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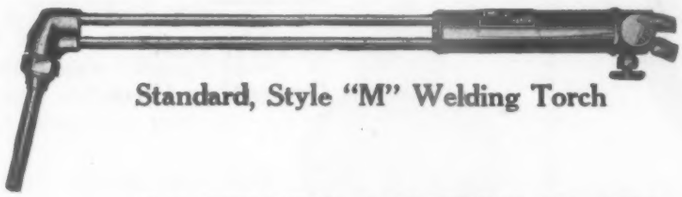
608 S. Dearborn St., Chicago, Ill.

Gas Mixture is a Fundamental in Making K-G Torches

Goose-neck, Style "A" Welding Torch

A welding torch is made primarily to mix acetylene and oxygen. Therefore, in making K-G Torches, our first consideration is to be sure of getting the correct mixture to produce a smooth neutral flame. By exercising the greatest possible accuracy in the proportioning of gas passages we are able to offer welders a torch which is extremely simple and consequently efficient. This same simplicity makes for a more durable tool, one on which the upkeep cost is practically nothing. Select your next torch from the K-G catalog.



Standard, Style "M" Welding Torch

DISTRIBUTORS and SERVICE STATIONS

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A. G. Sprague, 276 Davidson Ave., Perth Amboy, N. J.
Sight Feed Generator Co., West Alexandria, Ohio.
Welders Service Co., 229 Second Ave., Pittsburgh, Pa.
Passaic-Bergen Welding Works, 650 Main Ave., Clifton, N. J.
Passaic-Bergen Welding Works, 356 Fair St., Paterson, N. J.
Sutton-Garten Co., 217 W. 10th St., Indianapolis, Ind.
The Service Welding & Supply Co., 509 N. Park St., Columbus, Ohio.
Chicago Grinding & Machine Co., 2117 Tilden St., Chicago, Ill.
Motor Accessories Co., 1041 Hamilton St., Allentown, Pa.
Harry P. Winslow, 35 Vinton St., Worcester, Mass.
Wisconsin Motor Parts Co., 2446 Prairie Ave., Chicago, Ill.
Welders Supply Co., 700 McCulloch St., Baltimore, Md.
J. W. Evans Sons, 95 Brook St., Thompkinsville, Staten Island, N. Y.
Albany Welding & Boiler Works, 40 Madison Ave., Albany, N. Y.
H. Harrison Kress, 1718 Sansom St., Philadelphia, Pa.
Welding & Supplies Co., 3445 Parthenais St., Montreal, Can.
Welding & Supplies Co., Toronto, Can.
E. Brass Auto Supply Co., 307 Burnet St., New Brunswick, N. J.
Rocky Mountain Welders Supply, Denver, Colo.

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515 W. 29th St.
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A Welding Rod for Every Job

Electric ELECWELD Arc

Elecweld, one of our leading rods, is a low carbon rod for electric welding, medium hard, or annealed, furnished Flux Coated when desired. Recommended for wrought iron and steel tanks, boiler plates, angles, sheets, flues, etc., where higher tensile strength is required.

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Norweld Special	A*	Elecweld	E
Norweld	A	Steelweld	E
Castweld	A	Vanadweld	A&E
Bronzeweld	A	Hicarweld	A&E
Nickelweld	A&E	High Manganese	A&E

*Acetylene †Electric

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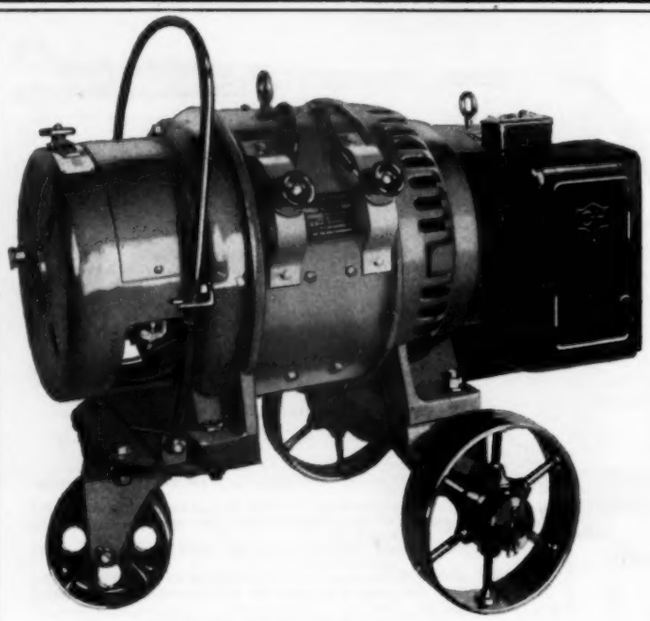

A Welder So Different
It Merits Investigation

No Exciter—
No External Stabilizer—No Rheostat
—One Control—

Arc Flexibility Hitherto Unapproached
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Lowest First Cost
Lowest Operating Cost

EQUIPMENT-SUPPLIES FUZON WELDING & CUTTING

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Compare Torchweld details and method of manufacturing with any other make of equipment which is claimed just as good. Your eye will tell you which is the better manufactured product.

Torchweld is original and distinctive and not an imitation. Its superior operation will outperform any other gas welding and cutting equipment.

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WELDERS who use Commercial Acetylene soon learn that every cylinder contains the same pure gas.

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Means pure acetylene.

COMMERCIAL SERVICE
Means prompt service.

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That welding wire test *did pay!*

as told by a man who made one

"Welding wire costs do not stop with the purchase of the wire. With the high prices we are paying expert welders now it does not take many bad pieces of wire to waste a lot of dollars in time.

Then you must consider the investment in the finished article being welded. A fraction of a percent of spoiled work or even poor work, may more than equal the total cost of the welding wire used.

We have found the best welding wire we can buy is the cheapest we can use because it saves expensive time. That is why we standardize on Page-Armco since we made our tests."

You can test Page-Armco Welding Wire in your own job. Your name and address will bring samples.

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Bridgeport, Connecticut
District Offices: Chicago, New York, Pittsburgh, San Francisco
An Associate Company of the American Chain Company, Incorporated, Bridgeport, Conn.

PAGE-ARMCO PROCESSED
Welding Wire *and* Electrodes

When buying CARBIDE — Ask for NATIONAL

BEST for All Industrial Purposes

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IN THE RED DRUM SAVES YOU MONEY

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ARE SPECIFIED ON IMPORTANT JOBS

Why?

Because the electrode material is of the correct composition to flow easily through the arc and produce a solid deposit of weld metal having the necessary physical properties. Because this material is processed under specialized control so as to develop ideal welding qualities to the highest degree.

Every member of the Hollup organization has specialized for years in the study of arc welding, and the production of arc welding materials is their exclusive occupation. Hollup Electrodes thus deserve the confidence of the engineers who specify them for welds which must not fail.

Write for Samples

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Of all the Hackney Acetylene Cylinders manufactured in the last 17 years, 99 7/10% are in active service today. Our records show that all of those now out of service were destroyed by fire or some other external force.

Such a record is virtually the same as a guarantee to acetylene producers who use Hackneys.

It is proof that Hackneys are so strong and sturdy that the worst shipping abuse has little or no effect.

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It means lower round trip costs and less depreciation.

It means safety for everyone who handles the cylinders.

And most important of all, it means greater acetylene *profits* every year.

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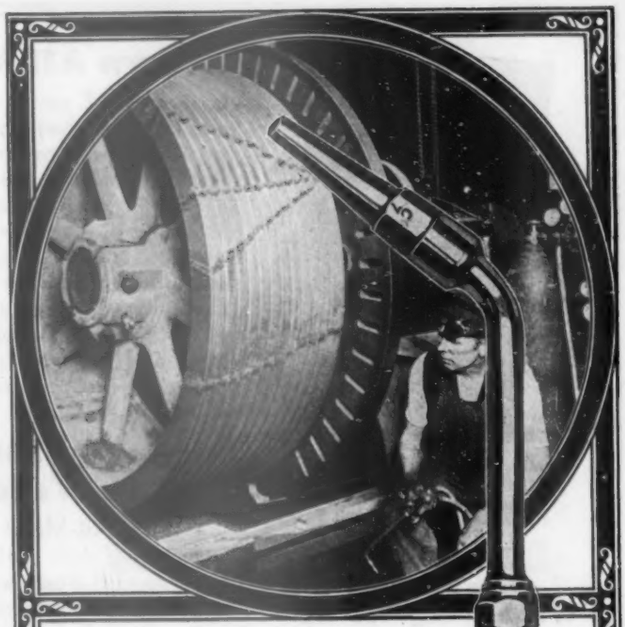

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is a mineral composition that repairs cracked waterjackets, motorheads, waterpumps, porous castings, etc., by simply heating the casting to 400° heat and rubbing on the Crown All-Metal Filler, which will penetrate through to the underside and rust up and make a guaranteed, permanent repair. Can be made to flow up, down or sideways. Being gray in color, it blends with cast iron and steel, although it can be used on all metals.

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Crown All-Metal Filler is the only compound that will make an electric weld on cast iron absolutely watertight. It penetrates through the smallest pinhole where it is possible for water to leak out, and the filler will rust, which is necessary for a permanent repair.

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Crown Aluminum Solder (hard) has been tested by the Bureau of Standards, Washington, D. C., and shown to possess tensile strength of 14,500 pounds to the square inch. Not only is Crown the strongest made, but the easiest to handle and apply, and the saving of labor makes Crown a necessity to every welder.

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Crown Iron Metallic Filler is the incomparable metal for filling scored cylinders. The special Crown acid is supplied free.

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OLDEST EXCLUSIVE MAKERS OF ALUMINUM SOLDERS

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Now in full production with

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(Patent applied for)

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Send a trial order for some KORO wire from the new plant.

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WAUKEGAN, ILLINOIS

A complete line of gas and electric welding wire.

MODEL "O"

has been designed to give the welder a maximum of comfort and protection embodied in the extreme lightness of weight, proper ventilation and the absolute exclusion of all outside light.

Model "O" Handshield

MODEL "O"

is made throughout of special vulcanized fibre of exceptional strength and wearing qualities. This shield carries the CESCO indorsement; your assurance that the degree of quality and workmanship is of the highest.

PRICE

Complete with ESSENTIALITE Lens
$5.00 *each.*

Manufactured by

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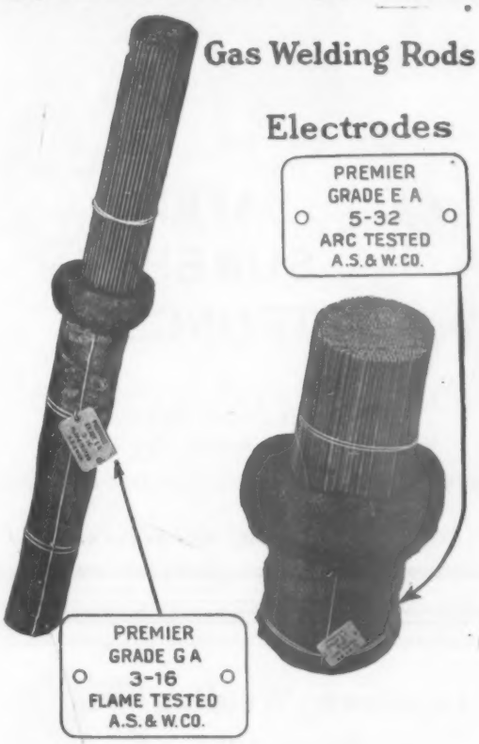
American Steel & Wire Company's

PREMIER

TESTED

WELDING WIRES



PREMIER Welding Wire flows freely, giving perfect fusion, thorough penetration and the desired finish. The uniform quality of Premier Welding Wire insures a deposit of metal in the weld free from foreign inclusions and possessing maximum strength. Before shipment, every bundle is electrically tested and manually welded. Permanently satisfactory welds and a saving of gas, electricity and the welder's time are thereby assured.

For a dependable welding job, use an appropriate grade of Premier Welding Wire. Send for booklet giving full information and specifications.

American Steel & Wire Co.

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Ten electric welding operators who can successfully demonstrate the application of electric welding and who are qualified to sell USL welding equipments.

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ELECTRIC ARC WELDER

STOP WASTING GAS

WELDIT GASAVER

can reduce your gas consumption 25%

PREVENTS burning gas while torch is idle. Hang torch on hook and flame goes out. To start again, simply pass torch tip over pilot light, and obtain the pre-adjusted flame. No time or gas is lost in getting started.

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Easily attached to all makes of portable and stationary outfits.

Approved by National Board of Underwriters Licensed Under Basic Patents

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Welding Torches	Cast Iron Rods
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Welding Wire	Safety Gloves
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634 Bagley Ave. DETROIT, MICH.

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SHOOT-A-LITE

See the safe distance of hand from flame

SAFE!
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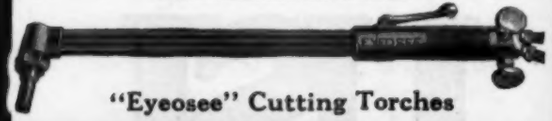

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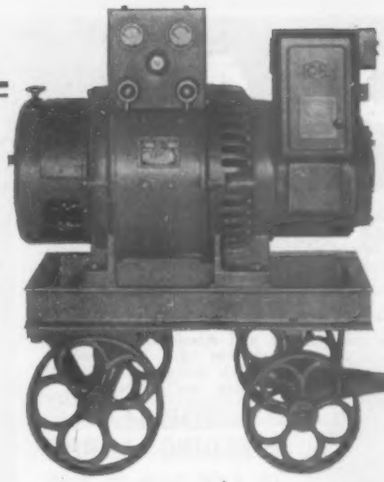

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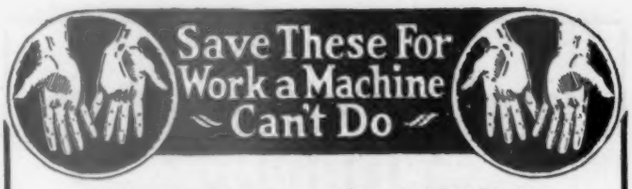

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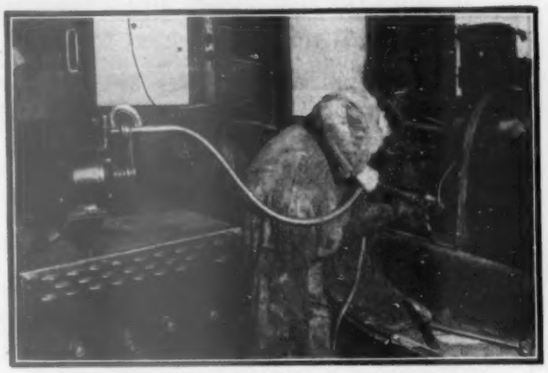

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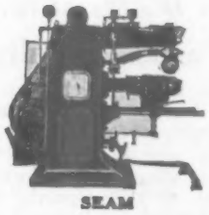

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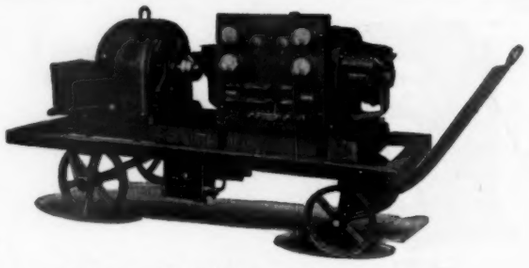

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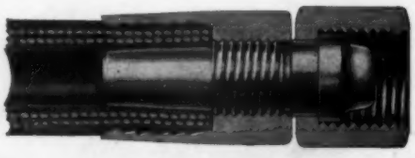

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Permits the holding of electrode with tremendous pressure, but requires only very slight pressure to release. Perfect electrical contact between electrode and holder, with elimination of current losses and overheating. For 1/16" to ¼" diameter electrodes.

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THE success of the use of Elkonite Welding Electrodes in spot welding dissimilar metals and alloys has brought it to the attention of welding engineers the country over.

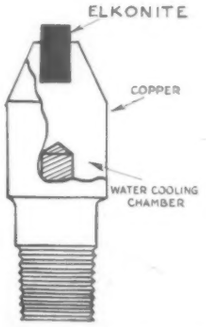

Fig. 1. Water cooled spot welding electrode showing Elkonite Insert. (Courtesy General Electric Co.)

The variable electrical and heat resistance of the different grades of Elkonite Welding Electrodes, plus their ability to hold their shape without mushrooming under red heat, heavy pressures and high currents are properties of immense value.

For this variable, relatively high resistance Elkonite as one electrode, with low resistance Elkonite or copper as the other, gives the balance necessary for even heating to welding temperature of metals of unequal heat and electrical conductivity, such as, for instance, copper with galvanized iron, or with nichrome.

METALS	ALUMINUM	ASCOLOY	BRASS	COPPER	GALVANIZED IRON	IRON	LEAD	MONEL	NICKEL	NICHROME	TIN PLATE	ZINC
ALUMINUM	•											
ASCOLOY		•		•	•	•		•	•	•	•	
BRASS			•	•	•	•		•	•	•	•	
COPPER		•	•	•	•	•		•	•	•	•	
GALVANIZED IRON		•	•	•	•	•		•	•	•	•	
IRON		•	•	•	•	•		•	•	•	•	
LEAD							•					
MONEL		•	•	•	•	•		•	•	•	•	
NICKEL		•	•	•	•	•		•	•	•	•	
NICHROME		•	•	•	•	•		•	•	•	•	
TIN PLATE		•	•	•	•	•		•	•	•		
ZINC												•

Fig. 2. Combinations of metals successfully welded with Elkonite. (Courtesy General Electric Co.)

This is but one phase of the contribution that Elkonite has made to resistance welding. In flash, cross-wire, projection welding, electrical upsetting of rivets, as well as in spot welding nonferrous and heavy gauge ferrous metals Elkonite, by eliminating lost time and production due to constant redressing, and shrinkage loss, is showing new economies and production possibilities in many industries.

Our engineering staff will gladly co-operate in any resistance welding problem.

ELKON WORKS Inc.
Subsidiary of P. R. Mallory & Co. Inc.
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Exclusive licensees under General Electric Co. patents dated May 28, 1925 and Sept. 1, 1925. Other patents pending to Elkon Works.

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Model C-300 — Rugged and flexible for structural steel and production welding.

Model F-650

Model F-650— For cutting risers and welding defective castings in foundries. Can be used with electric furnace transformer for 110-volt operation.

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